REPORT NUMBER: 214P-MGA-2011-011

SAFETY COMPLIANCE TESTING FOR FMVSS 214
DYNAMIC SIDE IMPACT PROTECTION
RIGID POLE

KIA MOTORS MANUFACTURING GEORGIA, INC.
2011 KIA SORENTO SUV
NHTSA NUMBER: CB0511

PREPARED BY:
MGA RESEARCH CORPORATION
5000 WARREN ROAD
BURLINGTON, WI 53105

Test Date: April 4, 2011

Report Date: June 28, 2011

FINAL REPORT

PREPARED FOR:
U.S. DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION
ENFORCEMENT
OFFICE OF VEHICLE SAFETY COMPLIANCE
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FINAL REPORT ACCEPTANCE BY OVSC:

Accepted by: James A. Jones

Acceptance Date: 7/7/2011

Technical Report Documentation Page

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7. Author(s) Donna Janovicz, Project Manager Joe Fleck, Project Engineer		*8. Performing Organization Report No.* 214P-MGA-2011-011
9. Performing Organization Name and Address MGA Research Corporation 5000 Warren Road Burlington, WI 53105		*10. Work Unit No.* *11. Contract or Grant No.* DTNH22-07-D-00062
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15. Supplementary Notes		

16. Abstract

A 32 km/h (20 mph), 75° oblique impact compliance test was conducted on the subject 2011 Kia Sorento SUV in accordance with the specifications of the Office of Vehicle Safety Compliance TP-214P-01 for the determination of FMVSS No. 214 Side Impact Protection compliance. The test was conducted at MGA Research Corporation, in Burlington, Wisconsin, on April 4, 2011.

The impact velocity was 31.5 km/h, and the ambient temperature at the struck (driver's) side of the test vehicle at the time of impact was 21°C. The test vehicle post-test maximum crush was 363 mm at level 3. The test vehicle's performance follows:

Measurement Description	Units	Result
Head Injury Criteria (HIC_{36})	N/A	315
Max. Rib Deflection	mm	22
Sum of Abdomen Forces	N	1226
Pubic Symphysis Force	N	2376

The doors on the struck side of the vehicle did not separate from the body at the hinges or latches and the opposite side doors did not open during the side impact event.

17. Key Words Compliance Testing Side Impact Protection Pole Test ES-2re SID-IIs		*18. Distribution Statement* Copies of this report are available from: National Highway Traffic Safety Administration Technical Information Services (TIS) Room E12-100 East Building 1200 New Jersey Ave. Washington, D.C. 20590 Telephone No. (202) 366-2588	
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Form DOT F1700.7 (8-72)

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PURPOSE AND SUMMARY OF TEST

PURPOSE

This side impact test is part of the FY 2011 FMVSS 214 Side Impact Protection Compliance Test Program sponsored by the National Highway Traffic Safety Administration (NHTSA), under Contract No. DTNH22-07-D-00062. The purpose of this test was to evaluate side impact protection in a 2011 Kia Sorento SUV. The side impact test was conducted in accordance with the Office of Vehicle Safety Compliance's Laboratory Test Procedure (TP-214P-01, dated January 2010).

SUMMARY

A rigid pole side impact test was conducted on a 2011 Kia Sorento SUV. The subject vehicle was towed into the rigid pole at an angle of 75° and a velocity of 31.5 km/h. The test was conducted by MGA Research Corporation in Burlington, Wisconsin, on April 4, 2011. Pre-test and post-test photographs of the test vehicle and side impact dummy are included in Appendix A of this report.

One Part 572U dummy was placed in the left front outboard designated seating position according to instructions specified in TP-214P-01, dated January 2010. The side impact event was documented by ten (10) cameras.

The ES-2re male dummy was instrumented with a triaxial accelerometer pack located in the head, 3 rib displacement transducers located in the chest, 3 load cells located in the abdomen and a load cell located in the pubic symphysis.

A summary of the test results follows:

DUMMY INJURY VALUES

Dummy	HIC (36ms)	Thorax Deflection (mm)		Abdomen Forces (N)		Pubic Symphysis (N)
ES-2re 50th Percentile Male	315	Upper	21.5	Front	281.2	2375.5
		Middle	20.0	Mid	520.5	
		Lower	22.1	Rear	547.4	
		Max.	22.1	Sum	1225.5	

GENERAL COMMENTS

There was no valid data collected for:

B Pillar Mid Y after 40 msec.

Roof Y after 10 msec.

MGA does not endorse or certify products. The manufacturer's name appears solely for identification purposes.

SECTION 2

OCCUPANT AND VEHICLE INFORMATION

DATA SHEET NO. 1

TEST VEHICLE INFORMATION AND OPTIONS

Test Vehicle: 2011 Kia Sorento SUV NHTSA No. CB0511
Test Program: FMVSS 214 Pole Test Date: 4/04/2011

VEHICLE INFORMATION	
Make	Kia
Model	Sorento
Body Style	MPV
VIN	5XYKT3A18BG147785
Body Color	Pacific Blue
Engine Displacement (L)	2.4
# of Cylinders	4
Engine Placement	Lateral
Transmission Type	Manual
Transmission Speeds	6
Overdrive	Yes
Final Drive	Front
Odometer Reading	132 miles

OPTIONS	
ESC	Yes
All Wheel Drive	No
Power Steering	Yes
Tilt Steering Wheel	Yes
Driver Side Curtain Airbag	Yes
Driver Side Torso/Pelvis Airbag	Yes
Driver Knee Bag	No
Driver Seat Belt Pretentioners	Yes
Driver Seat Belt Load Limiters	Yes
Driver Power Seat	No
Rear Pass. Curtain Airbag	Yes
Rear Pass. Side Torso Airbag	No
Rear Pass. Seat Belt Pretentioners	No
Rear Pass. Seat Belt Load Limiters	No
Rear Pass. Power Seats	No
Power Windows	Yes
Air Conditioning	Yes
AM/FM CD	Yes
Automatic Door Locks (ADL)	Yes
Does owner's manual provide instructions to disable ADL's?	No
Anti-Lock Brakes	Yes

DATA FROM CERTIFICATION LABEL

Manufactured By	Kia Motors Manufacturing Georgia, Inc.
Date of Manufacture	JAN/21/11

GVWR (kg)	2190
GAWR Front (kg)	1350
GAWR Rear (kg)	1450

VEHICLE SEATING AND CAPACITY WEIGHT INFORMATION

Measured Parameter	Front	Rear	Third	Total
Type of Seats	Bucket	Split Bench		
Number of Occupants	2	3		5
Capacity Weight (VCW) (kg)				420
Cargo Weight (RCLW) (kg)				80

DATA SHEET NO. 2

GENERAL TEST AND VEHICLE PARAMETER DATA

Test Vehicle: 2011 Kia Sorento SUV NHTSA No. CB0511
Test Program: FMVSS 214 Pole Test Date: 4/04/2011

TIRE PRESSURES

	Units	LF	RF	RR	LR
As Delivered	kPa	230	230	230	230
As Tested	kPa	230	230	230	230

TEST VEHICLE WEIGHTS

	Units	As Delivered			Fully Loaded			As Tested		
		Front Axle	Rear Axle	Total	Front Axle	Rear Axle	Total	Front Axle	Rear Axle	Total
Left	kg	464.0	359.7		494.0	432.8		493.5	418.7	
Right	kg	474.5	347.0		474.5	401.0		488.1	396.4	
Ratio	%	57.0	43.0		53.7	46.3		54.6	45.4	
Totals	kg	938.5	706.7	1645.2	968.5	833.8	1802.3	981.6	815.1	1796.7

TEST VEHICLE TARGET WEIGHT (TVTW) CALCULATION

Measured Parameter	Units	Value
As Delivered Weight	kg	1645.2
Weight of 1 P572U ATD (ES-2re) Dummy	kg	77.1
Rated Cargo/Luggage Weight (RCLW)	kg	80
Calculated Target Vehicle Test Weight (TVTW)	kg	1802.3

TEST VEHICLE ATTITUDES

	Units	LF	RF	RR	LR
Fully Loaded	mm	801	801	783	778
As Tested	mm	801	801	793	796
Difference	mm	0	0	-10	-18

CALCULATION OF THE VERTICAL IMPACT REFERENCE LINE

Measurement Parameter	Units	Value
Test Vehicle Wheel Base	mm	2705
Vertical Impact Reference Line (Aft of Front Axle)	mm	1296

WEIGHT of BALLAST and VEHICLE COMPONENTS REMOVED TO MEET VEHICLE TEST WEIGHT

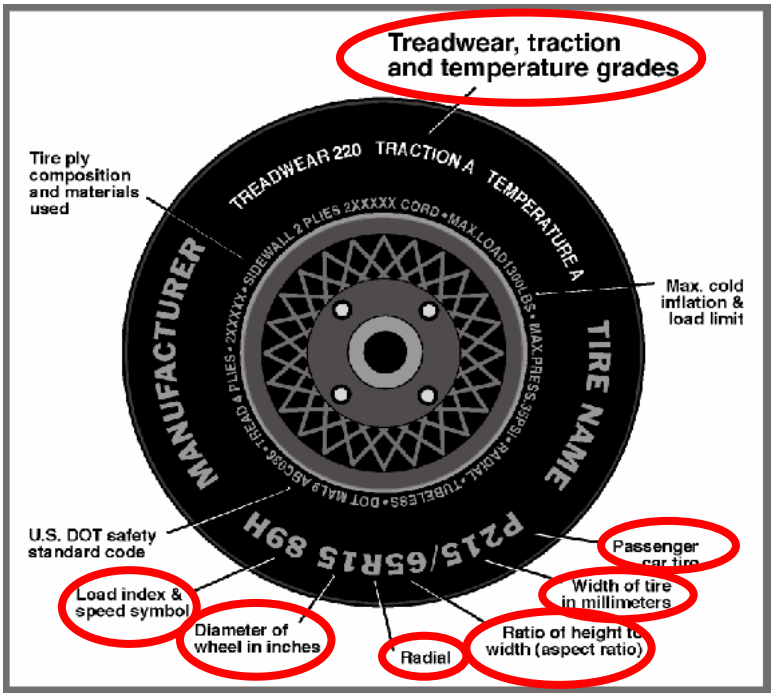
Description of Component	Weight (kg)
Ballast	0
No vehicle components removed to meet VTW	0

DATA SHEET NO. 3

VEHICLE TIRE INFORMATION

Test Vehicle: 2011 Kia Sorento SUV NHTSA No. CB0511
Test Program: FMVSS 214 Pole Test Date: 4/04/2011

VEHICLE TIRE INFORMATION



Measured Parameter	Front	Rear
Max. Tire Pressure (kPa)	300	300
Cold Pressure (kPa)	230	230
Recommended Tire Size	P235/65R17	P235/65R17
Tire Size on Vehicle	P235/65R17	P235/65R17
Tire Manufacturer	KUMHO	KUMHO
Tire Name	SOLUS	SOLUS
Tire Type	Passenger	Passenger
Tire Width	235	235
Aspect Ratio	65	65
Radial	Yes	Yes
Wheel Diameter	17	17
Load Index/Speed Symbol	103T	103T
Treadwear	500	500
Traction Grade	A	A
Temperature Grade	A	A

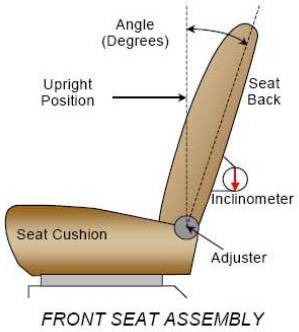
DATA SHEET NO. 4

SEAT AND SEAT BELT ADJUSTMENT DATA

Test Vehicle: 2011 Kia Sorento SUV NHTSA No. CB0511
Test Program: FMVSS 214 Pole Test Date: 4/04/2011

NORMAL DESIGN RIDING POSITION

The driver seat back is positioned to the manufacturer's designated angle. The procedure is as follows: Seat back angle is measured at the headrest post with the inclinometer zeroed at the side sill. Set the seat back angle at -0.7 degrees.



FRONT SEAT ASSEMBLY

SEAT BACK ANGLE

	Degrees	Detents
Driver with Seated Dummy	-0.2° at headrest post	

SEAT FORE/AFT POSITION

The method used for determining seat fore/aft position is as follows: For seat track adjustments, set in mid track position.

SEAT FORE/AFT POSITIONING

	Total Fore/Aft Travel	Placed in Position #
Front Seat	24 detents	12th detent (forward-most as 0)

SEAT BELT UPPER ANCHORAGE

The method of positioning the seat belt upper anchorage is as follows: Detents to the nominal design position are measured with respect to the uppermost detent. Place at the uppermost detent for the 50th percentile male.

SEAT BELT UPPER ANCHORAGE

	Total # of Positions	Placed in Position #
Driver Seat	4 detents	0 detent (uppermost detent defined as 0)

HEADREST RESTRAINT

The headrest was placed in the uppermost position.

DATA SHEET NO. 5

FUEL SYSTEMS AND STEERING WHEEL POSITION DATA

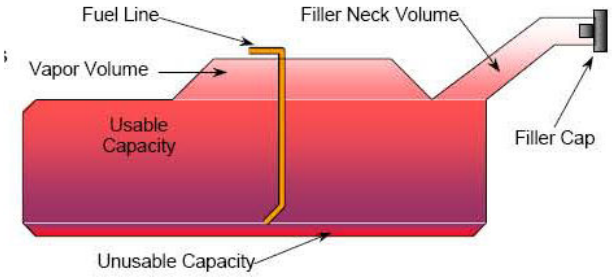
Test Vehicle: 2011 Kia Sorento SUV NHTSA No. CB0511
Test Program: FMVSS 214 Pole Test Date: 4/04/2011

FUEL TANK CAPACITY

	Liters
Usable Capacity (Form 1)	68.0
Usable Capacity (Owner's Manual)	68.0
92-94% of Usable Capacity	62.6 to 63.9
Actual Amount of Solvent Used	63.2

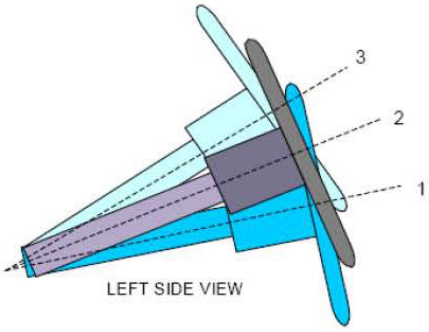
FUEL PUMP

Describe the fuel pump type, its behavior, and the location of the fuel filler pipe. The test vehicle is equipped with an electric fuel pump. Fuel pump will operate when key is in the "ON" position. The fuel pipe is on the left side.



STEERING COLUMN ADJUSTMENT

Steering wheel and column adjustments are made so that the steering wheel hub is at the center of its geometric locus it describes when it moves through its full range of motion. An aluminum plate is placed across the rim of the steering wheel, an inclinometer is placed on the plate and the angle is measured.



STEERING COLUMN ASSEMBLY

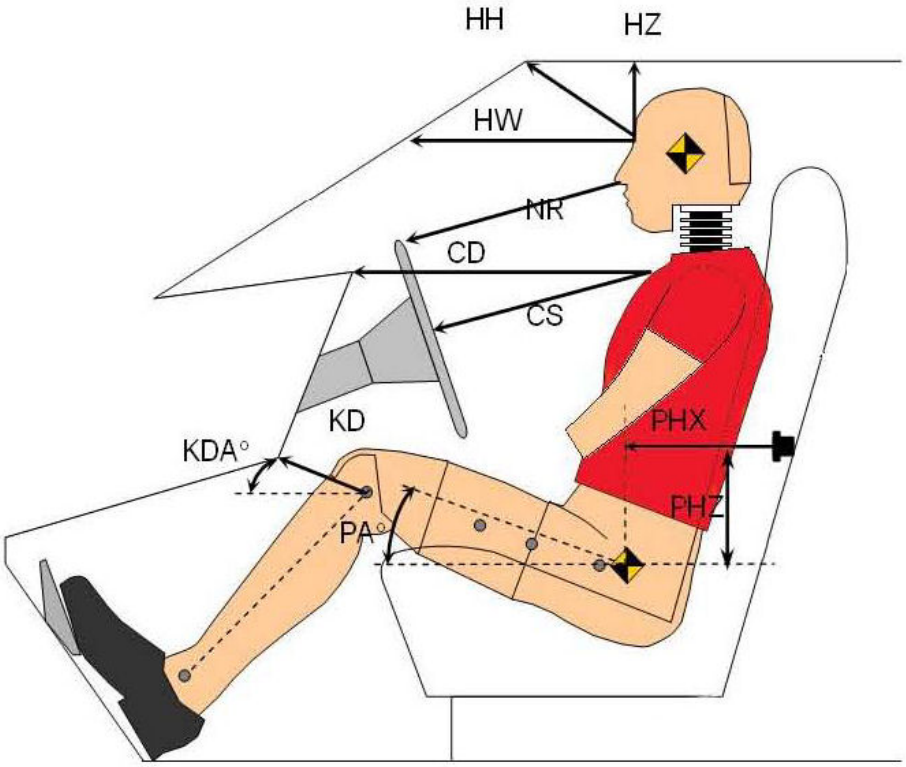
STEERING COLUMN POSITIONING

	Degrees	Fore/Aft Position (mm)
Lowermost - Position 1	66.6	132
Geometric Center – Position 2	64.3	112
Uppermost – Position 3	61.9	92
Telescoping Steering Wheel Travel		40
Test Position	64.3	112

.DATA SHEET NO. 6

DUMMY LONGITUDINAL CLEARANCE DIMENSIONS

Test Vehicle: 2011 Kia Sorento SUV NHTSA No. CB0511
Test Program: FMVSS 214 Pole Test Date: 4/04/2011

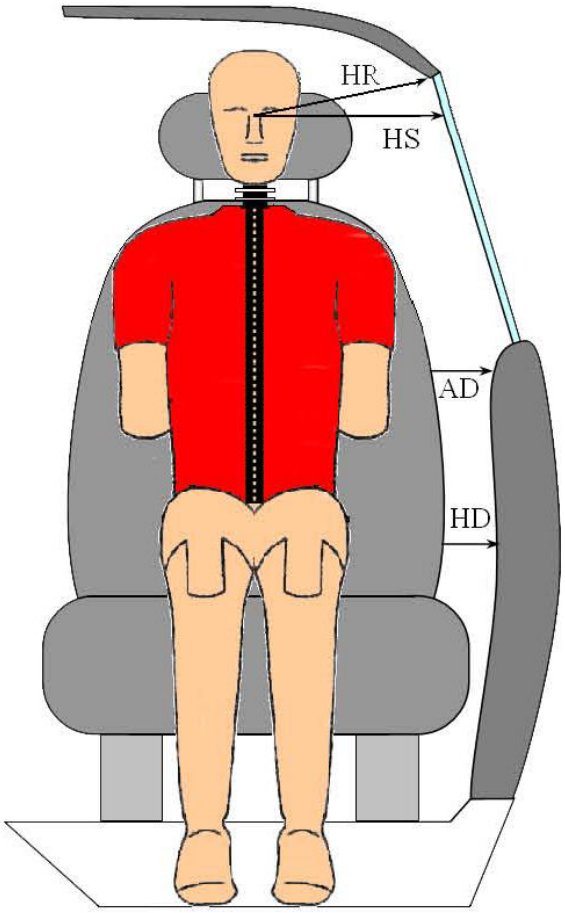


Driver Code	Measurement Description	Length (mm)	Angle (°)
HH	Head to Header	338	
HW	Head to Windshield	605	
HZ	Head to Roof	170	
NR	Nose to Rim	448	
CD	Chest to Dash	553	
CS	Chest to Steering Wheel	336	
KDL	Left Knee to Dash	135	21.4
KDR	Right Knee to Dash	120	20.6
PA	Pelvis Angle X		26.4
	Torso Angle Y		0.8
PHX	H-Point to Striker (X-Axis)	206	
PHZ	H-Point to Striker (Z-Axis)	201	

DATA SHEET NO. 7

DUMMY LATERAL CLEARANCE DIMENSIONS

Test Vehicle: 2011 Kia Sorento SUV NHTSA No. CB0511
Test Program: FMVSS 214 Pole Test Date: 4/04/2011

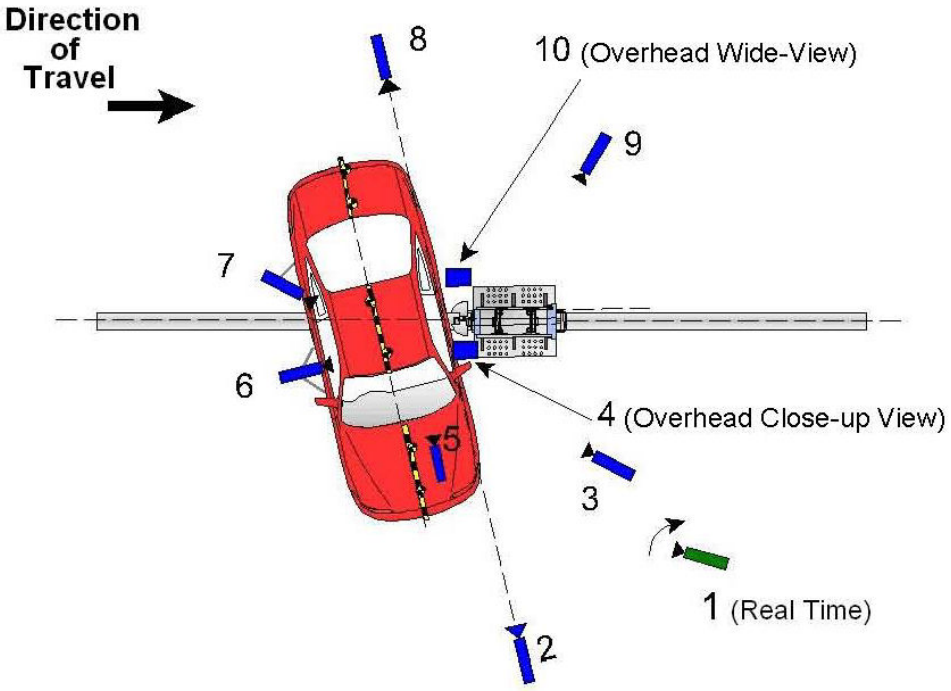


Code	Measurement Description	Units	Front Occupant
HR	Head to Side Header	mm	188
HS	Head to Side Window	mm	324
AD	Arm to Door	mm	96
HD	H-Point to Door	mm	153

DATA SHEET NO. 8

HIGH SPEED CAMERA LOCATIONS AND DATA

Test Vehicle: 2011 Kia Sorento SUV NHTSA No. CB0511
Test Program: FMVSS 214 Pole Test Date: 4/04/2011



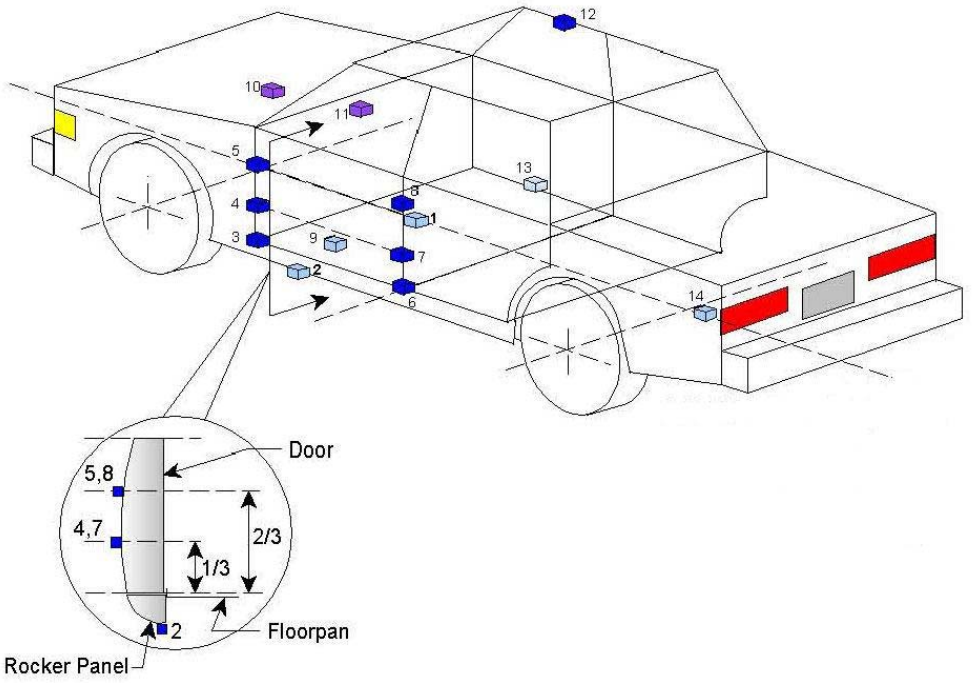
Reference: From Point of Impact for X and Y; from Ground for Z):
+X = Right of Impact, + Y = Forward of Impact, +Z = Up

Camera No.	View	Coordinates (mm)			Lens (mm)	Film Speed (fps)
		X	Y	Z		
1	Real-Time					30
2	Front Ground Level	6090	40	1740	24	1000
3	Impact Side 45° Forward	4630	2230	1820	20	1000
4	Overhead Closeup	0	-50	4520	50	1000
5	Onboard – Driver Front				16	1000
6	Onboard – Driver Side				8	1000
7	Onboard – Driver Rear				8	1000
8	Rear Ground Level	-5750	40	1770	24	1000
9	Impact Side 45° Rearward	-3880	3790	1830	20	1000
10	Overhead Wide	0	-310	4610	14	1000

DATA SHEET NO. 9

TEST VEHICLE ACCELEROMETER LOCATIONS

Test Vehicle: 2011 Kia Sorento SUV NHTSA No. CB0511
Test Program: FMVSS 214 Pole Test Date: 4/04/2011



Loc. No.	Accelerometer Location			
	ID	Coordinates (mm)		
		X	Y	Z
1	Vehicle CG	2465	-210	-360
2	Left Floor Sill	2645	-750	-305
3	A Pillar Sill	3220	-755	-300
4	A Pillar Low	3140	-735	-645
5	A Pillar Mid	3155	-850	-930
6	B Pillar Sill	2125	-750	-310
7	B Pillar Low	2110	-745	-725
8	B Pillar Mid	2110	-735	-955
9	Seat	2275	-573	-555
10	Engine	3925	0	-887
11	Firewall	3610	0	-1056
12	Roof	1980	610	-1720
13	Floor Sill	2170	750	-310
14	Rear Deck	295	0	-635

Reference: X – Test Vehicle Rear Bumper (+ forward)
Y – Test Vehicle Centerline (+ to right)
Z – Ground Plane (+ down)

DATA SHEET NO. 10

TEST VEHICLE ACCELEROMETER DATA SUMMARY

Test Vehicle: 2011 Kia Sorento SUV NHTSA No. CB0511
Test Program: FMVSS 214 Pole Test Date: 4/04/2011

Loc. No.	Description	Peak Values (g's)			
		Max	Time (ms)	Min	Time (ms)
1	Vehicle CG (X)	2.0	142.4	-5.2	55.4
	Vehicle CG (Y)	19.1	50.4	-5.7	76.3
	Vehicle CG (Z)	8.2	17.7	-10.1	43.8
	Resultant	19.6	34.3		
2	Left Floor Sill (Y)	65.4	10.9	-10.7	37.3
3	A Pillar Sill (Y)	12.9	28.5	-1.5	8.3
4	A Pillar Low (Y)	22.3	41.1	-2.6	35.8
5	A Pillar Mid (Y)	16.2	17.7	-7.0	9.3
6	B Pillar Sill (Y)	62.8	10.9	-1.3	269.3
7	B Pillar Low (Y)	53.0	15.5	-10.0	21.7
8	B Pillar Mid (Y)	(1)	(1)	(1)	(1)
9	Seat (Y)	60.8	28.5	-20.7	40.5
10	Engine (X)	18.9	94.4	-16.4	38.2
	Engine (Y)	12.1	73.0	-2.0	216.9
11	Firewall (Y)	11.1	48.3	-1.2	3.6
12	Roof (Y)	(2)	(2)	(2)	(2)
13	Floor Sill (Y)	14.1	46.0	-1.0	267.8
14	Rear Deck (X)	2.8	136.0	-5.4	59.2
	Rear Deck (Y)	14.8	57.6	-1.9	300.0

(1) No valid data collected for B Pillar Mid Y after 40 msec.
(2) No valid data collected for Roof Y after 10 msec.

DATA SHEET NO. 11

DUMMY INJURY RESPONSE DATA

Test Vehicle: 2011 Kia Sorento SUV NHTSA No. CB0511
Test Program: FMVSS 214 Pole Test Date: 4/04/2011

Dummy S/N	Positive		Negative	
	MAX	**TIME (ms)**	**MAX**	**TIME (ms)**
HEAD ACCELERATION (G)				
Longitudinal (X)	5.1	170.2	21.1	63.3
Lateral (Y)	53.7	53.2	8.5	79.1
Vertical (Z)	11.7	40.4	9.2	66.6
Resultant (R)	55.6	53.2		
HIC36 (t1, t2)	315		t1 = 42.0	t2 = 67.0
THORAX DEFLECTION (mm)				
Upper Rib			21.5	44.3
Middle Rib			20.0	42.7
Lower Rib			22.1	56.0
ABDOMINAL FORCES (N)				
Front	281.2	48.2		
Middle	520.5	48.9		
Rear	547.4	49.2		
Sum	1225.5	49.0		
PELVIS FORCE (N)				
Pubic Symphysis			2375.5	56.2

Reference: Positive Direction -Longitudinal (X) = forward
-Lateral (Y) = to right
-Vertical (Z) = down

DATA SHEET NO. 12

POST TEST OBSERVATIONS

Test Vehicle: 2011 Kia Sorento SUV NHTSA No. CB0511
Test Program: FMVSS 214 Pole Test Date: 4/04/2011

TEST DUMMY INFORMATION AND CONTACT

Description	Front Occupant
Dummy Type / Serial No.	ES-2re / 016
Head Contact	Curtain Airbag, Headrest
Upper Torso Contact	Side Airbag, Door Panel
Lower Torso Contact	Side Airbag
Left Knee Contact	Door Panel
Right Knee Contact	Left Knee

POST TEST DOOR OPENING AND SEAT TRACK INFORMATION

Description	Front	Rear
Left Side Doors	Remained closed and jammed shut	Remained closed and jammed shut
Right Side Doors	Remained closed and operational	Remained closed and operational
Hatch and Other Doors	Remained closed and operational	Remained closed and operational
Seat Movement	0	0
Seat Back Failure	None	None

POST-TEST STRUCTURAL OBSERVATIONS

Critical Areas of Performance	Observations and Conclusions
Pillar Performance	No Separation
Sill Separation	None
Windshield Damage	Cracked
Window Damage	Left Front Window Broke
Other Notable Effects	None

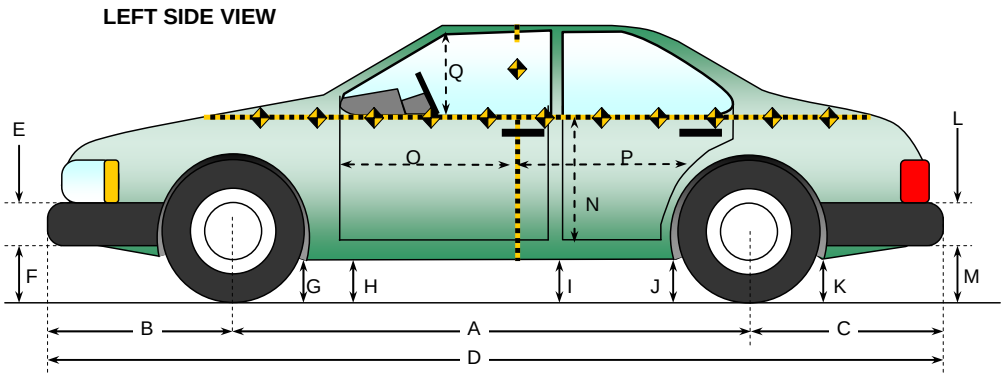
SUPPLEMENTAL RESTRAINT SYSTEM INFORMATION

Restraint Type	Front Occupant	
	Installed	Operated
Frontal Airbag	Yes	No
Side Torso/Pelvis Airbag	Yes	Yes
Head Airbag	No	
Curtain Airbag	Yes	Yes
Knee Airbag	No	
Seat Belt Pretensioner	Yes	Yes
Seat Belt Load Limiter	Yes	

DATA SHEET NO. 13

VEHICLE PRE TEST AND POST TEST MEASUREMENTS

Test Vehicle: 2011 Kia Sorento SUV NHTSA No. CB0511
Test Program: FMVSS 214 Pole Test Date: 4/04/2011

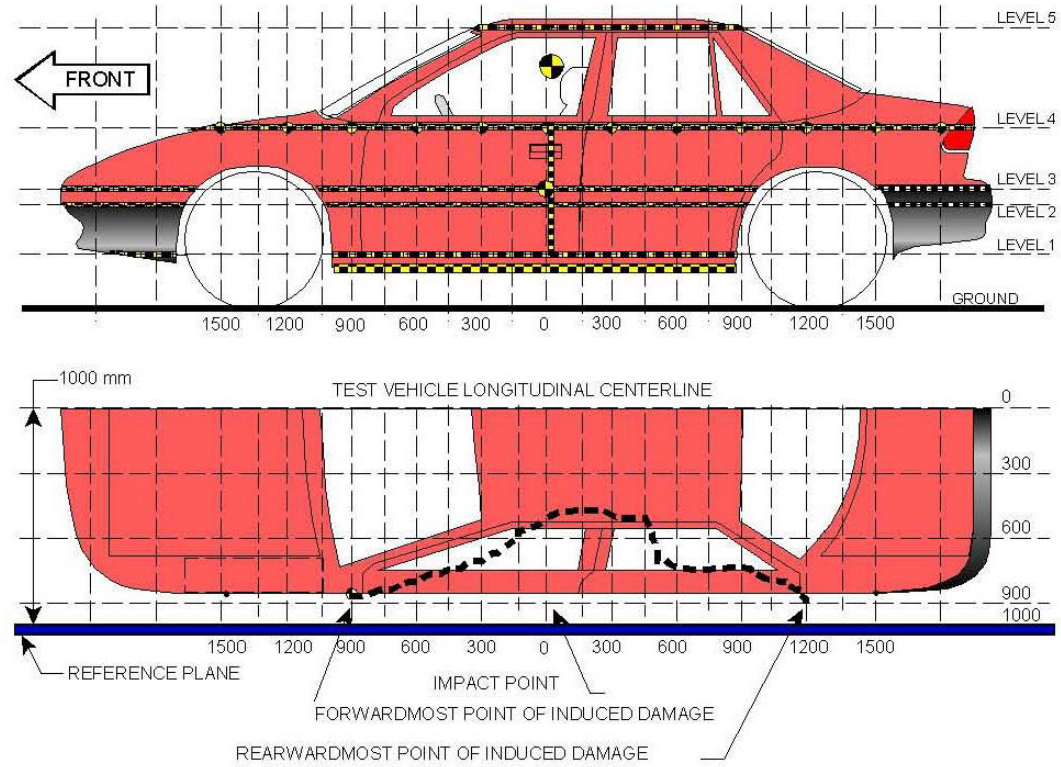


Code	Measurement Description	Pre-Test (mm)	Post-Test (mm)	Difference (mm)
A	Wheelbase	2705	2620	85
B	Front Axle to FSOV	1045	1040	5
C	Rear Axle to RSOV	930	980	-50
D	Total Vehicle Length at Centerline	4680	4640	40
E	Front Bumper Thickness	95	95	0
F	Front Bumper Bottom to Ground	355	355	0
G	Sill Height at Front Wheel Well	267	263	4
H	Sill Height at Front Door Leading Edge	265	253	12
I	Sill Height at B Pillar	273	265	8
J1	Sill Height at Rear Wheel Well	276	297	-21
J2	Pinch Weld Height at Rear Wheel Well	275	283	-8
K	Sill Height Aft of Rear Wheel Well	305	322	-17
L	Rear Bumper Thickness	110	110	0
M	Rear Bumper Bottom to Ground	351	358	-7
N	Sill Height to Window Bottom Sill	806	822	-16
O	Front Door Leading Edge to Impact CL	770	770	0
P	Rear Door Trailing Edge to Impact CL	1183	1215	-32
Q	Front Window Opening	490	454	36
R	Right Side Length	3736	3750	-14
S	Left Side Length	3736	3635	101
T	Vehicle Width at B Post	1858	1655	203

DATA SHEET NO. 14

EXTERIOR CRUSH MEASUREMENTS

Test Vehicle: 2011 Kia Sorento SUV NHTSA No. CB0511
Test Program: FMVSS 214 Pole Test Date: 4/04/2011



NOTE: All measurements are in millimeters (mm)

Maximum Exterior Crush Measurements

Level	Measurement Description	Maximum Exterior Static Crush	Distance from Impact	Height Above Ground (mm)
1	Sill Top	306	0	372
2	Occupant H-Point	362	75	763
3	Mid-Door	363	75	785
4	Window Sill	309	0	1135
5	Window Top	129	0	1632

DATA SHEET NO. 15

VEHICLE EXTERIOR CRUSH PROFILES

Test Vehicle: 2011 Kia Sorento SUV NHTSA No. CB0511
Test Program: FMVSS 214 Pole Test Date: 4/04/2011

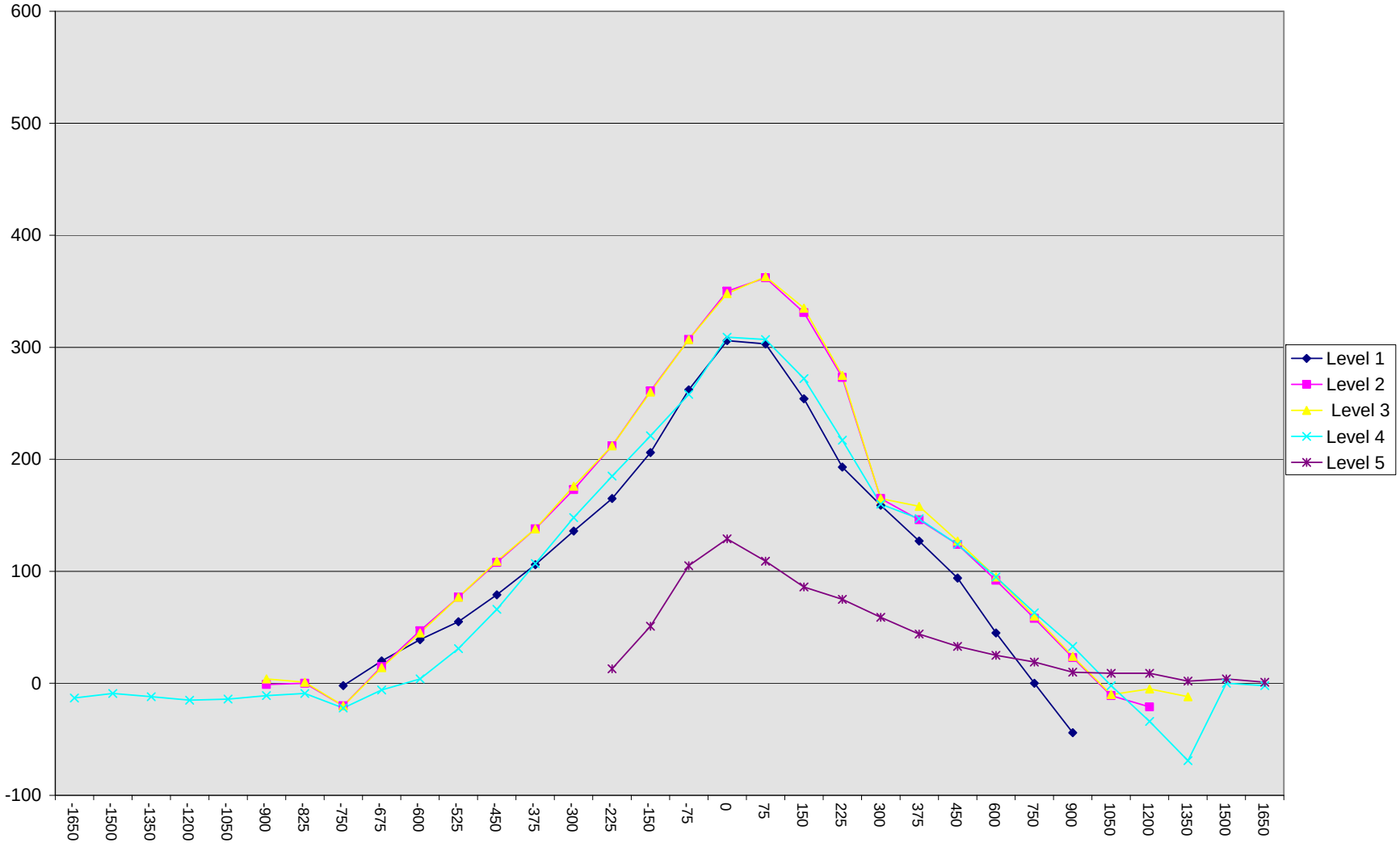
	Level 1	Level 2	Level 3	Level 4	Level 5
Maximum Crush (mm)	306	362	363	309	129
Distance From Impact (mm)	0	75	75	0	0

	Pre-Test					Post-Test					Difference				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
-1650				303					290					-13	
-1500				282					273					-9	
-1350				267					255					-12	
-1200				255					240					-15	
-1050				247					233					-14	
-900		166	166	240			165	170	229			-1	4	-11	
-825		171	173	245			171	174	236			0	1	-9	
-750	211	178	178	254		209	158	158	232		-2	-20	-20	-22	
-675	211	178	178	251		231	193	192	245		20	15	14	-6	
-600	211	178	178	249		250	225	223	253		39	47	45	4	
-525	212	178	178	246		267	255	255	277		55	77	77	31	
-450	211	176	176	244		290	284	285	310		79	108	109	66	
-375	211	176	176	240		317	314	314	347		106	138	138	107	
-300	211	176	176	239		347	349	352	387		136	173	176	148	
-225	211	176	176	236	470	376	388	388	421	483	165	212	212	185	13
-150	211	175	175	235	463	417	436	435	456	514	206	261	260	221	51
-75	212	175	175	233	457	474	482	482	491	562	262	307	307	258	105
0	212	175	175	231	456	518	525	523	540	585	306	350	348	309	129
75	212	175	175	230	455	515	537	538	537	564	303	362	363	307	109
150	212	175	175	229	458	466	506	510	501	544	254	331	335	272	86
225	212	175	175	228	457	405	448	450	445	532	193	273	275	217	75
300	212	174	174	226	458	371	339	339	386	517	159	165	165	160	59
375	212	174	174	225	460	339	320	332	372	504	127	146	158	147	44
450	212	175	175	225	461	306	299	302	349	494	94	124	127	124	33
600	211	176	176	224	462	256	268	271	319	487	45	92	95	95	25
750	210	178	178	225	465	210	236	238	288	484	0	58	60	63	19
900	212	180	180	225	469	168	203	204	258	479	-44	23	24	33	10
1050		169	170	227	473		158	160	225	482		-11	-10	-2	9
1200		165	165	229	478		144	160	195	487		-21	-5	-34	9
1350			165	231	488			153	162	490			-12	-69	2
1500				237	498				237	502				0	4
1650				244	512				242	513				-2	1

DATA SHEET NO. 15 (CONTINUED)

VEHICLE EXTERIOR CRUSH PROFILES

Test Vehicle: 2011 Kia Sorento SUV NHTSA No. CB0511
Test Program: FMVSS 214 Pole Test Date: 4/04/2011



DATA SHEET NO. 16

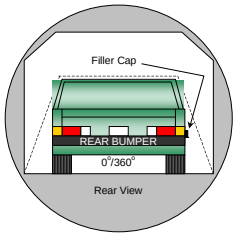
SUMMARY OF FMVSS 301 FUEL SYSTEM DATA

Test Vehicle: 2011 Kia Sorento SUV
Test Program: FMVSS 214 Pole
NHTSA No. CB0511
Test Date: 4/04/2011

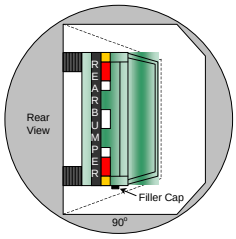
FUEL SYSTEM INTEGRITY POST IMPACT DATA

Time Interval	FMVSS 301 Maximum Allowable Spillage	Spillage (g)
Impact Until Motion Ceases	28 g	0
First Five Minutes Following Impact	142 g	0
Next 25 Minutes	28 g / 1 minute	0

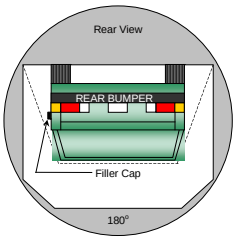
STATIC ROLLOVER DATA



0/360



90



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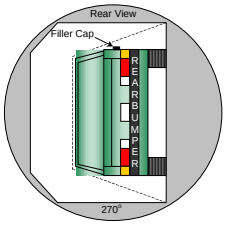


270

REAR VIEW

Rollover Stage	Rotation Time (spec. 1-3 min)				FMVSS 301 Hold Time		Total Time				Next Whole Minute Interval	
0° - 90°	2	minutes	00	seconds	5	minutes	7	minutes	00	seconds	8	minutes
90° - 180°	1	minutes	58	seconds	5	minutes	6	minutes	58	seconds	7	minutes
180° - 270°	1	minutes	56	seconds	5	minutes	6	minutes	56	seconds	7	minutes
270° - 360°	1	minutes	59	seconds	5	minutes	6	minutes	59	seconds	7	minutes

Rollover Stage	Spillage (g)			
	First 5 min. from onset of rotation	6^{th} min.	7^{th} min.	8^{th} min. (if required)
0° - 90°	0	0	0	
90° - 180°	0	0	0	
180° - 270°	0	0	0	
270° - 360°	0	0	0	
FMVSS 301 Maximum Allowable (for each 90° stage)	142	28	28	28

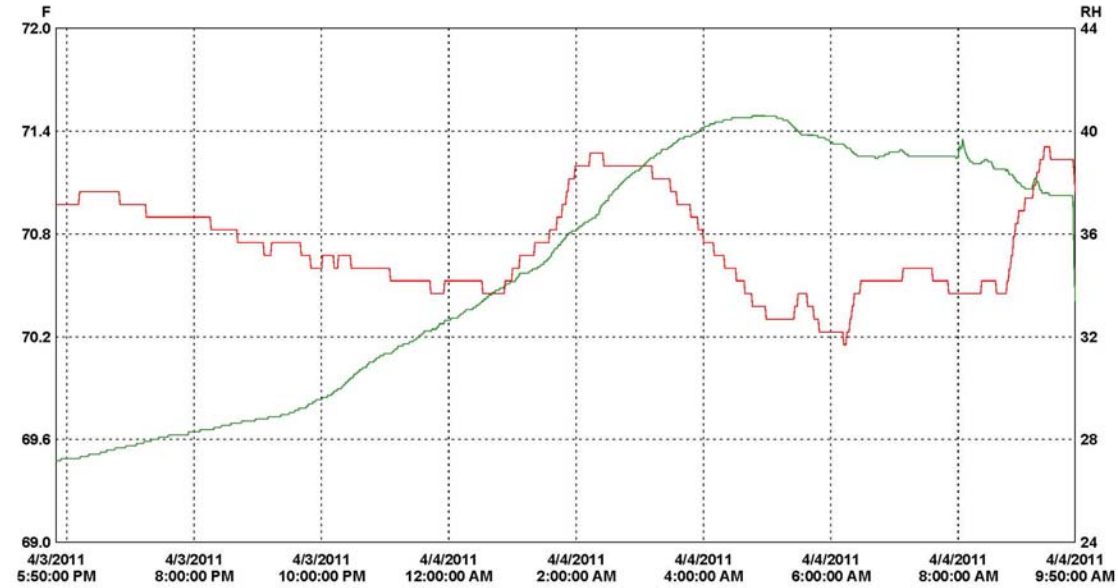
Rollover Stage	Spillage Location(s)
0° to 90°	None
90° to 180°	None
180° to 270°	None
270° to 360°	None

DATA SHEET NO. 17

TEMPERATURE AND HUMIDITY TRACES

Test Vehicle: 2011 Kia Sorento SUV NHTSA No. CB0511
Test Program: FMVSS 214 Pole Test Date: 4/04/2011

Time of Impact: 9:46 am



LN	Serial #	Description	CH	Value	Maximum	Average	Minimum	Units	CH description	Logger file
1	10102056	Vehicle Prep	1		71.31	70.73	70.15	F	Temperature	10102056_Vehicle_Prep.spl
2	10102056	Vehicle Prep	2		40.6	34.6	27.2	RH	Humidity	10102056_Vehicle_Prep.spl

APPENDIX A

PHOTOGRAPHS

TABLE OF PHOTOGRAPHS

Pre-Test Frontal View of Test Vehicle

Post-Test Frontal View of Test Vehicle

Pre-Test Rear View of Test Vehicle

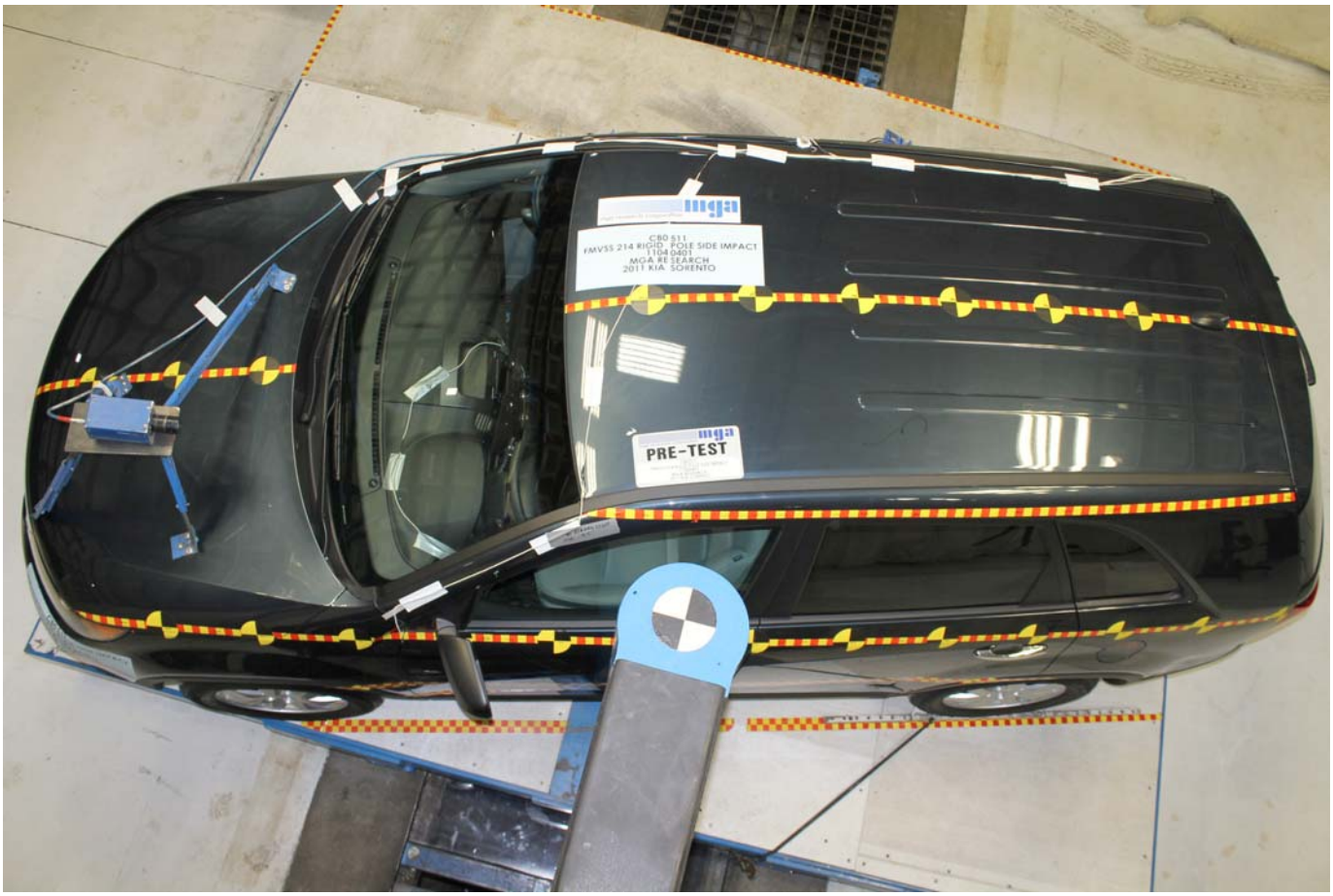
Post-Test Rear View of Test Vehicle

Pre-Test Impacted Side View of Test Vehicle

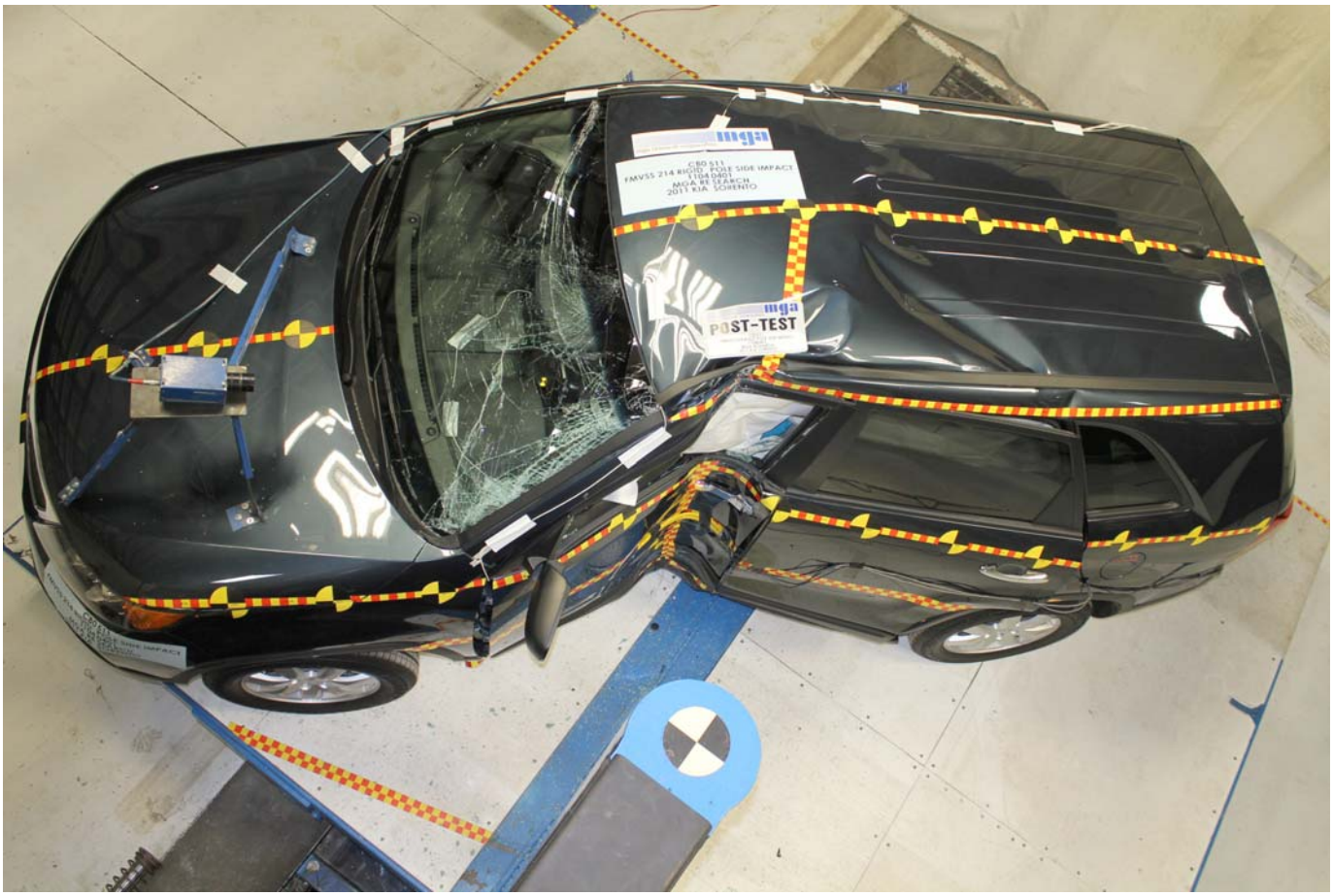
Post-Test Impacted Side View of Test Vehicle

Pre-Test Left ¾ Front View of Vehicle and Pole

Pre-Test Left ¾ Rear View of Vehicle and Pole



Pre-Test Overhead View of Test Vehicle



Post-Test Overhead View of Test Vehicle

Pre-Test Dummy Through Opposite Window

Post-Test Dummy Through Opposite Window

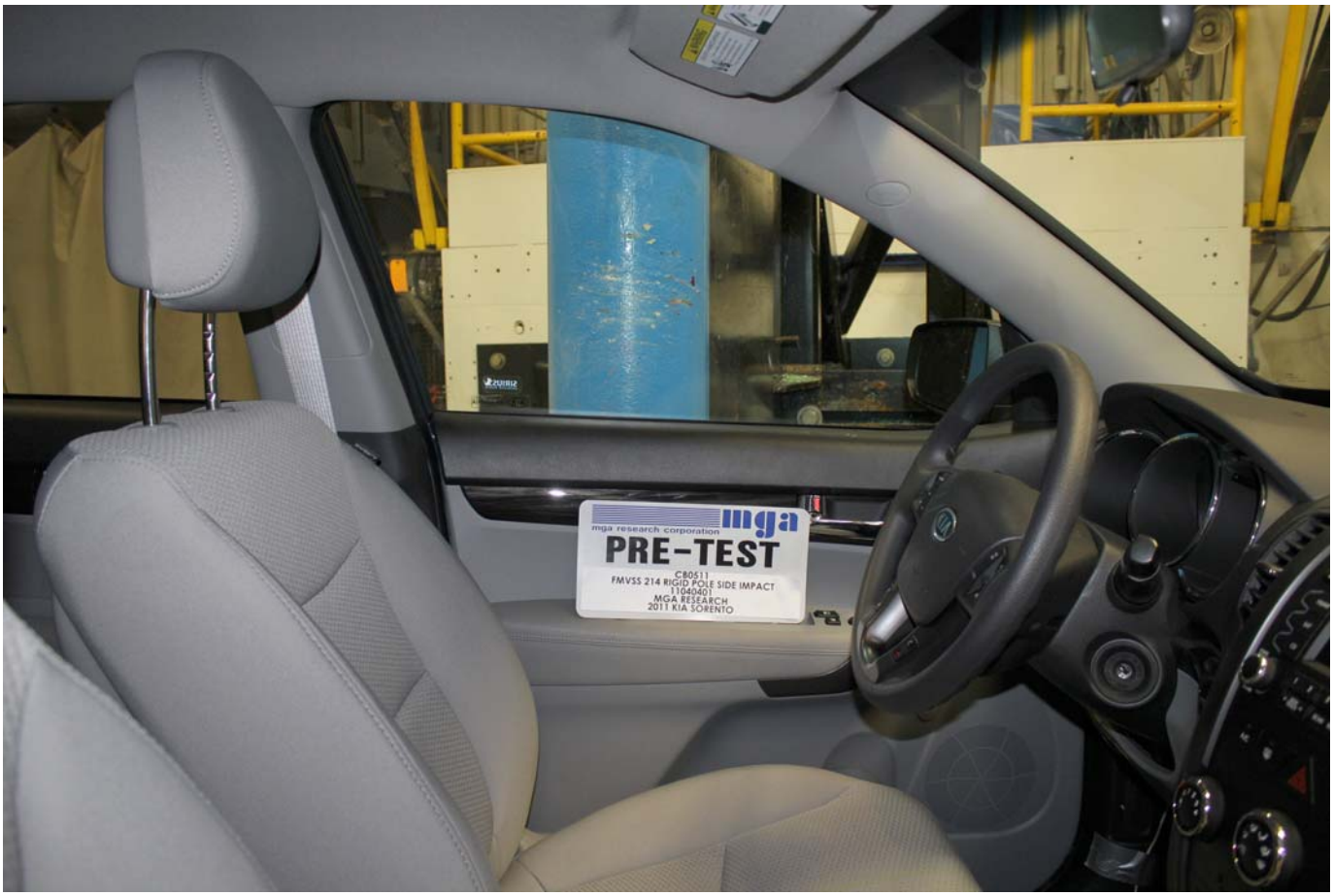
Pre-Test Close-up of Dummy with Door Closed (Impact Side)

Post-Test Dummy with Door Closed (Impact Side)

Pre-Test Dummy Door Open

Pre-Test Dummy Shoulder and Door Top View

Post-Test Dummy Shoulder and Door Top View



Pre-Test Interior of Front Door Closed

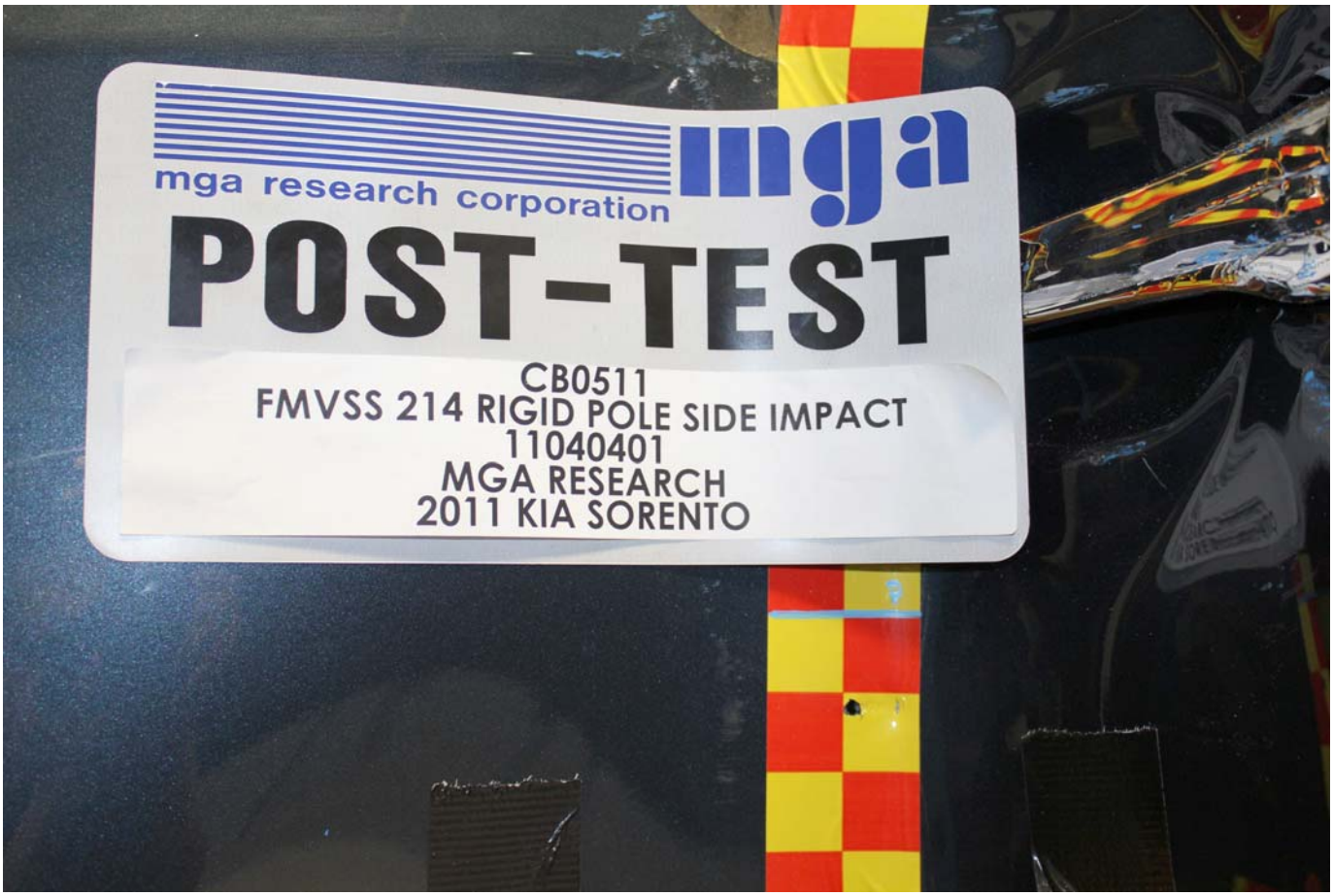
Post-Test Interior of Front Door Showing Dummy Impact Locations

Impact Event

Post-Test Impact Zone Close-up View

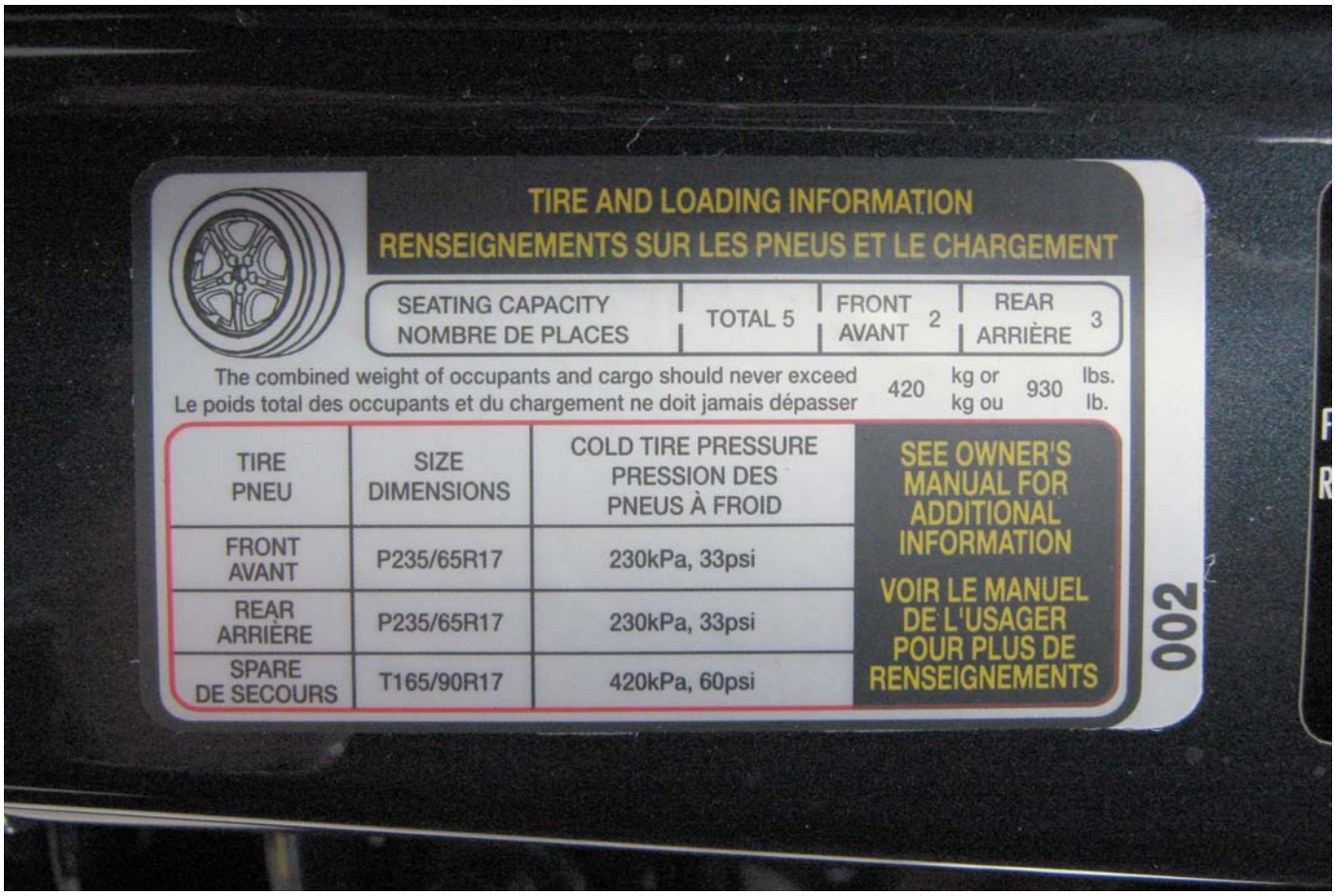
Post-Test ¾ Front View of Impact Zone

Post-Test ¾ Rear View of Impact Zone

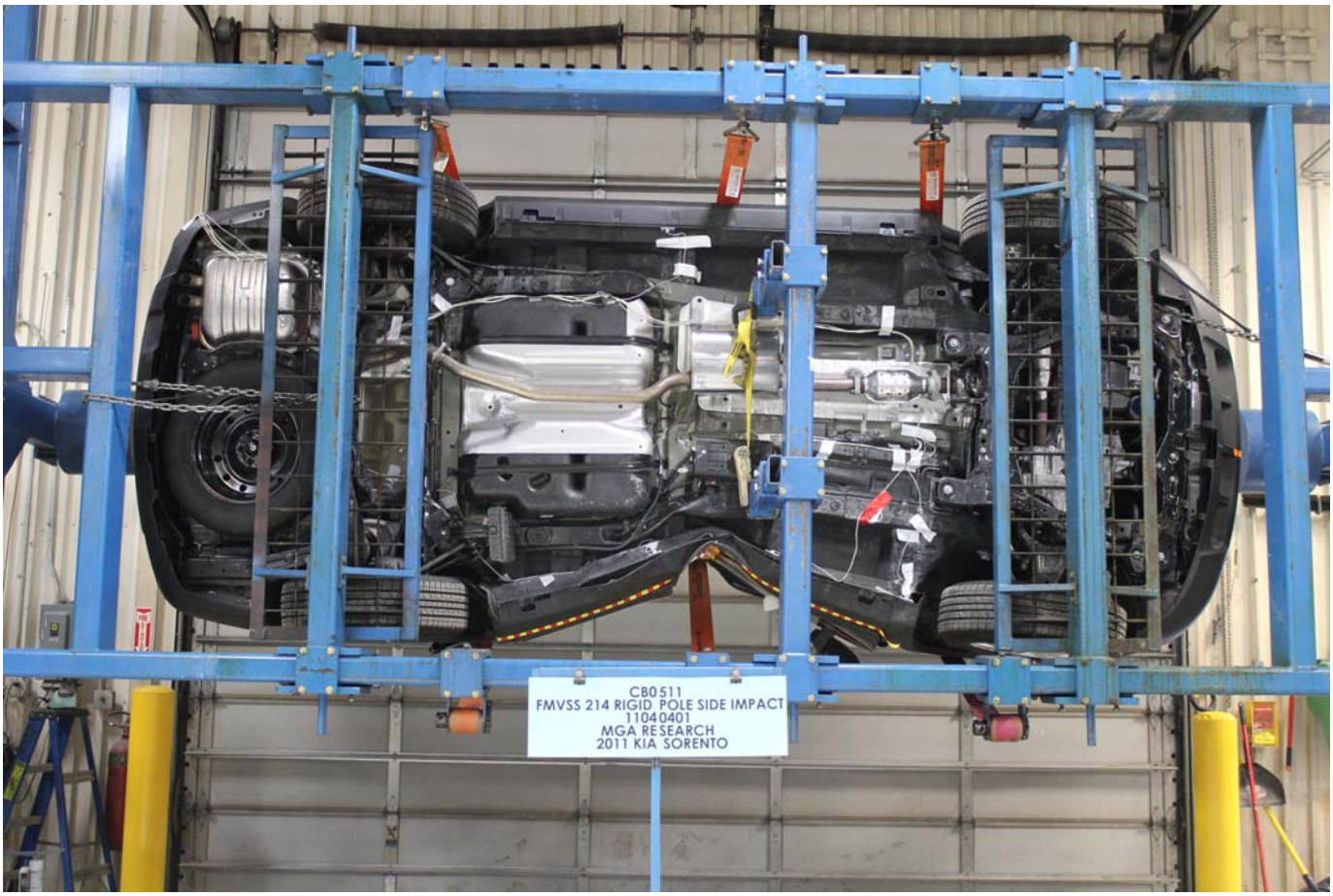


Post-Test Close-up View of Impact Point Target

Close-up View of Vehicle's Certification Label



Close-up View of Vehicle's Tire Placard Label



Post-Test Vehicle at 90 Degree Rollover

Post-Test Vehicle at 180 Degree Rollover

Post-Test Vehicle at 270 Degree Rollover

Post-Test Vehicle at 360 Degree Rollover

APPENDIX B

DUMMY RESPONSE DATA

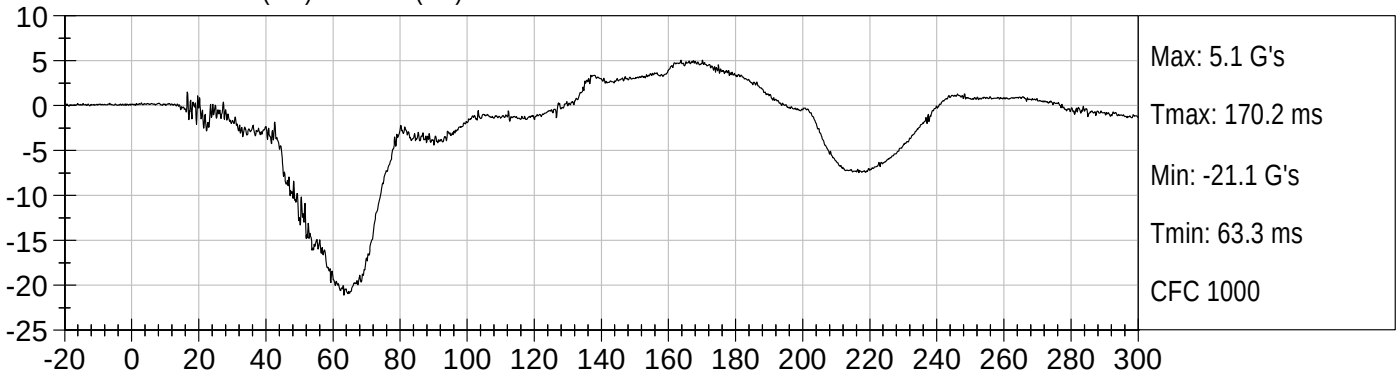
TABLE OF DATA PLOTS

Dummy Instrumentation Plots
FILTERED DATA

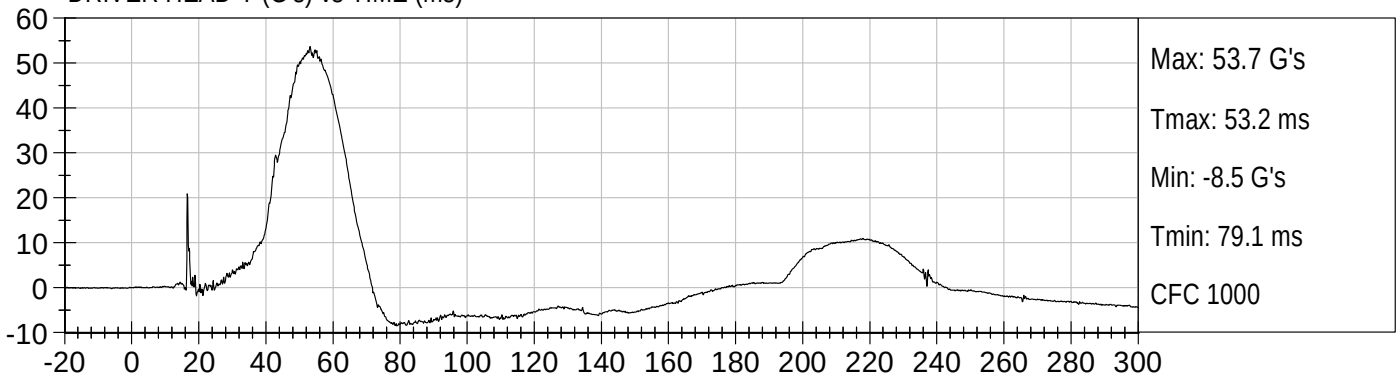
FMVSS 214 Rigid Pole Side Impact
2011 Kia Sorento - CB0511

Test Date: 04/04/2011
Speed: 19.6 mph (31.5 km/h)

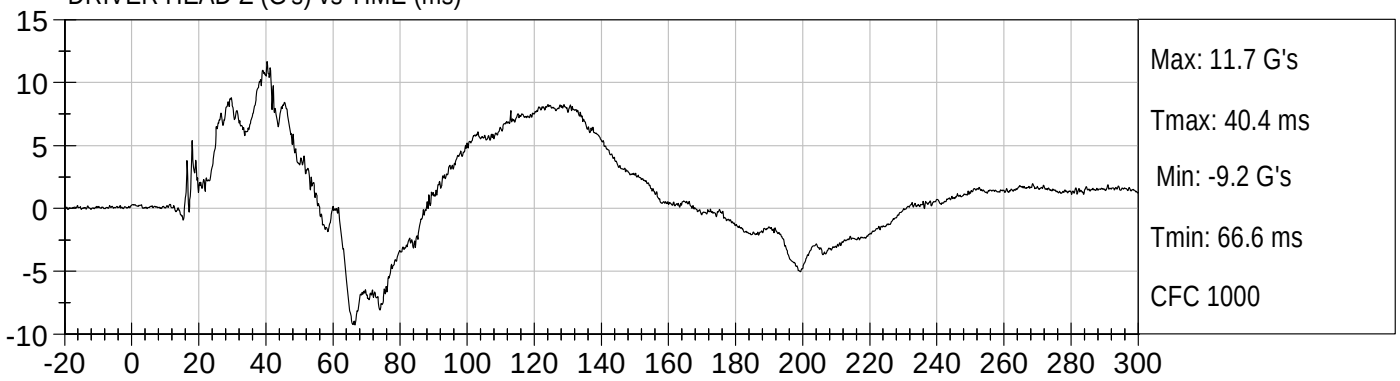
DRIVER HEAD X (G's) vs TIME (ms)



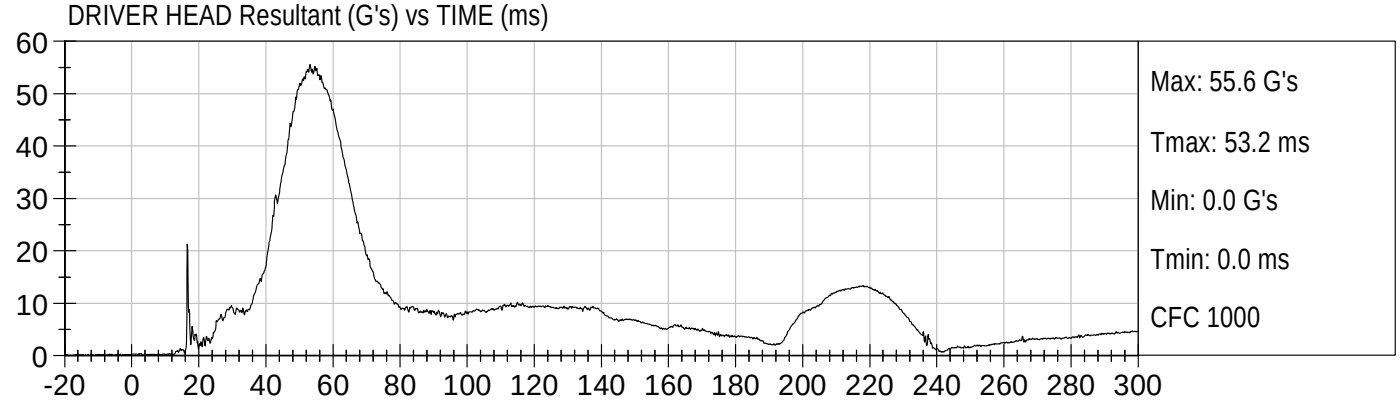
DRIVER HEAD Y (G's) vs TIME (ms)



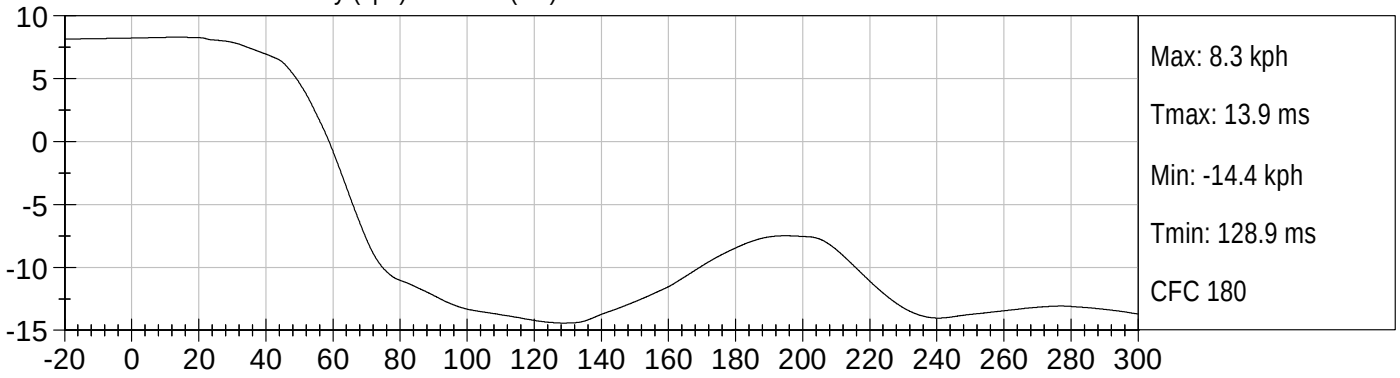
DRIVER HEAD Z (G's) vs TIME (ms)



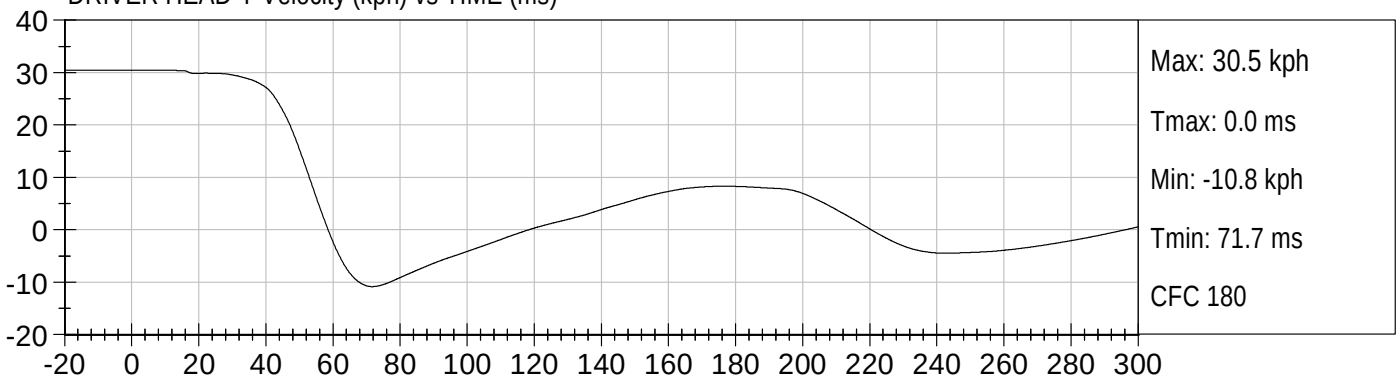
DRIVER HEAD Resultant (G's) vs TIME (ms)



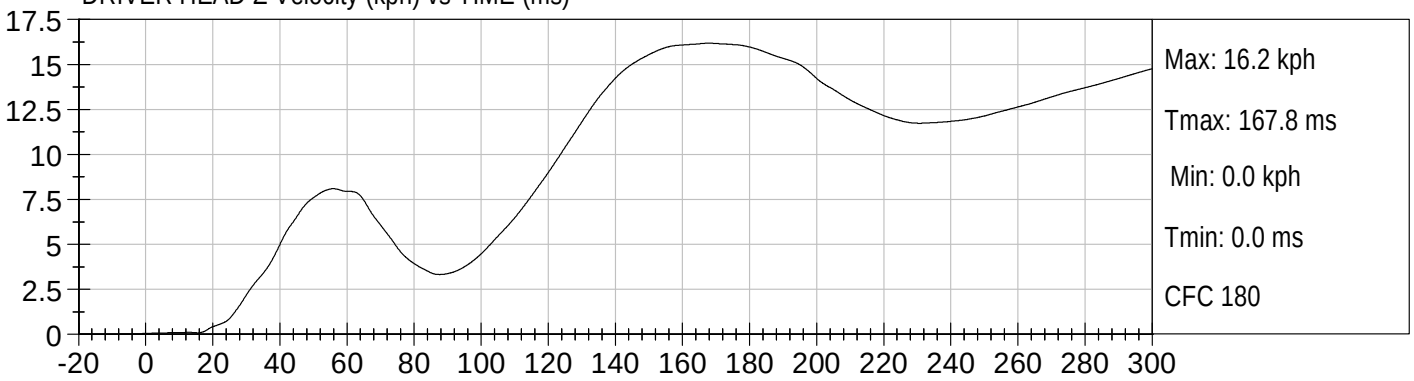
DRIVER HEAD X Velocity (kph) vs TIME (ms)



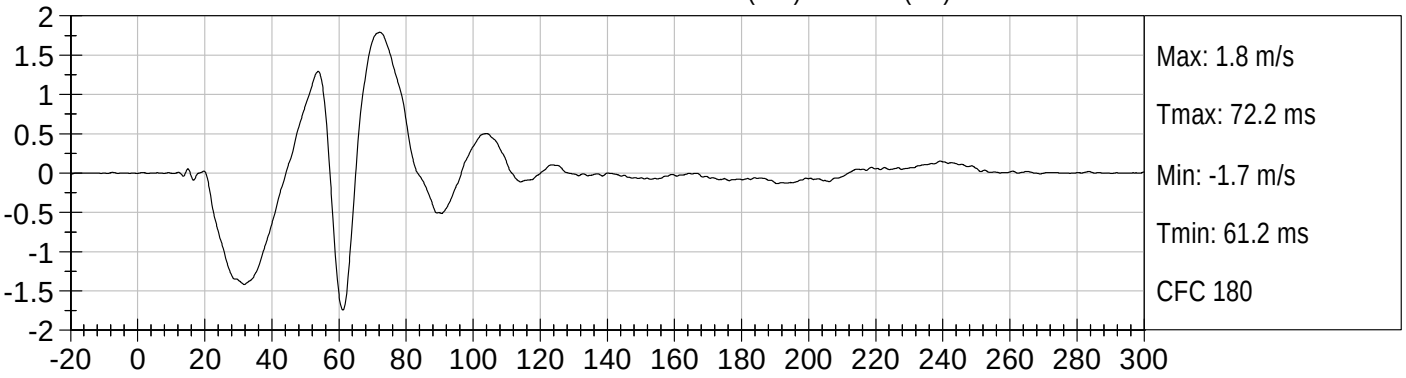
DRIVER HEAD Y Velocity (kph) vs TIME (ms)



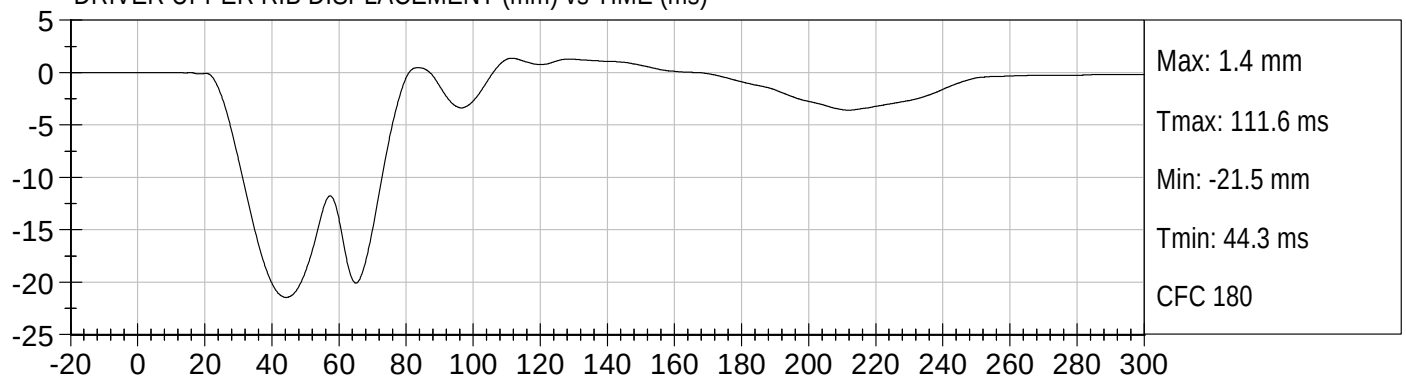
DRIVER HEAD Z Velocity (kph) vs TIME (ms)



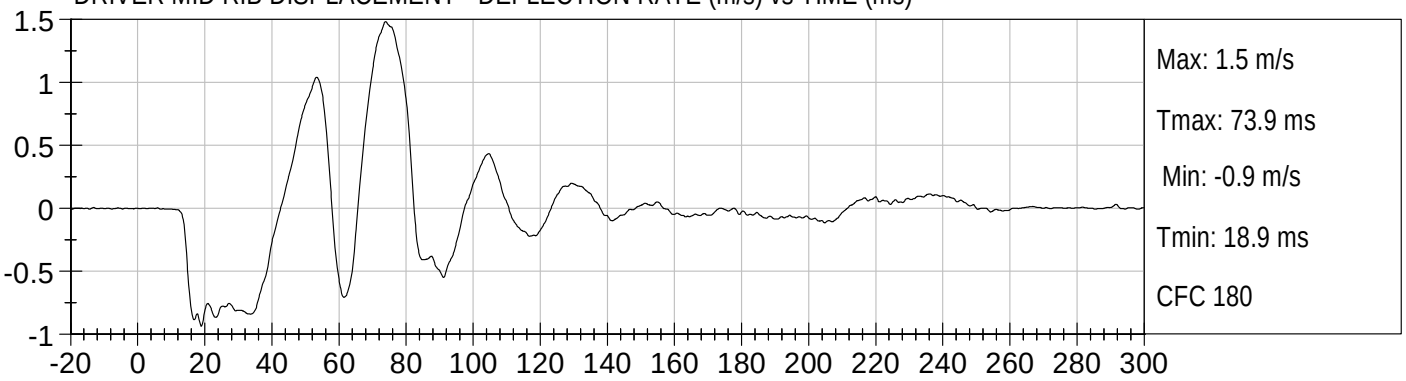
DRIVER UPPER RIB DISPLACEMENT - DEFLECTION RATE (m/s) vs TIME (ms)



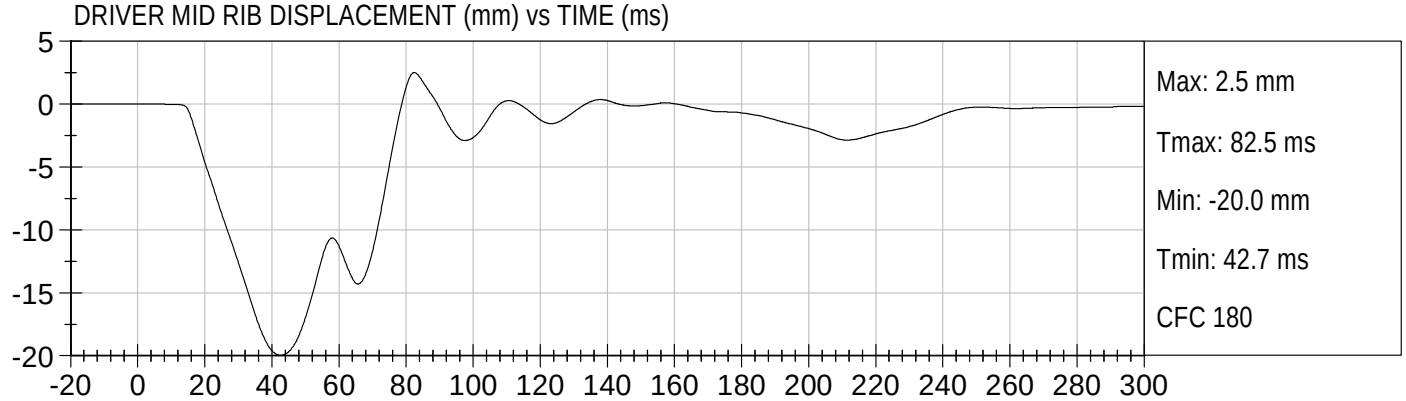
DRIVER UPPER RIB DISPLACEMENT (mm) vs TIME (ms)



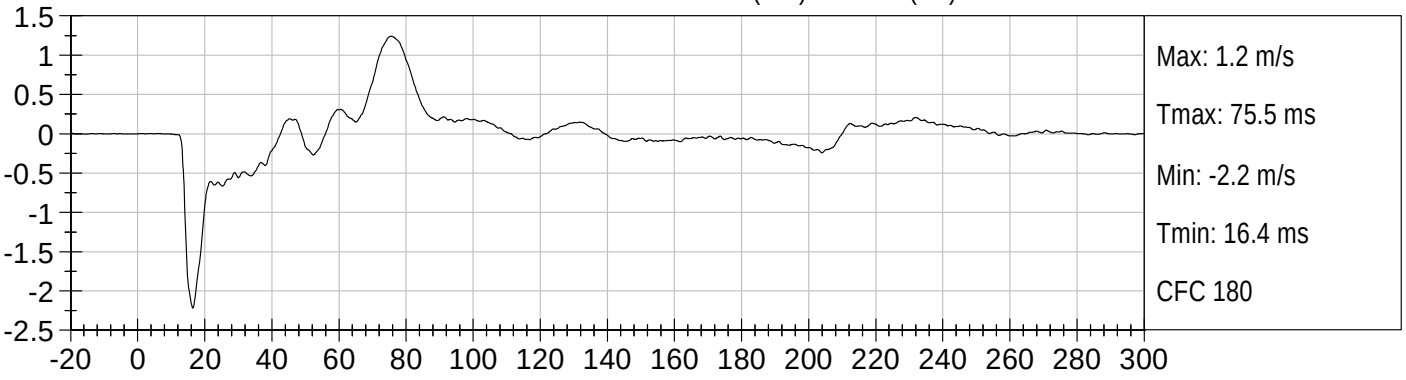
DRIVER MID RIB DISPLACEMENT - DEFLECTION RATE (m/s) vs TIME (ms)



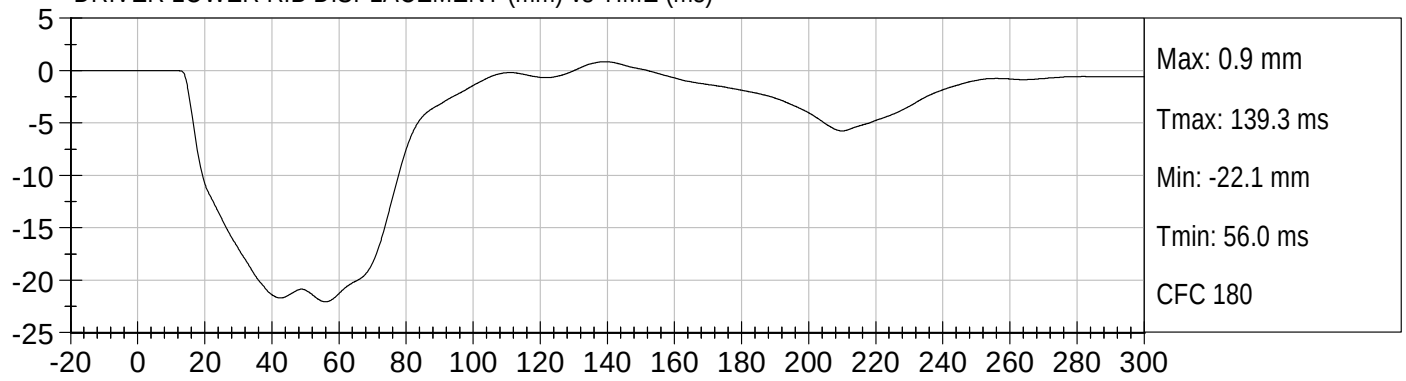
DRIVER MID RIB DISPLACEMENT (mm) vs TIME (ms)



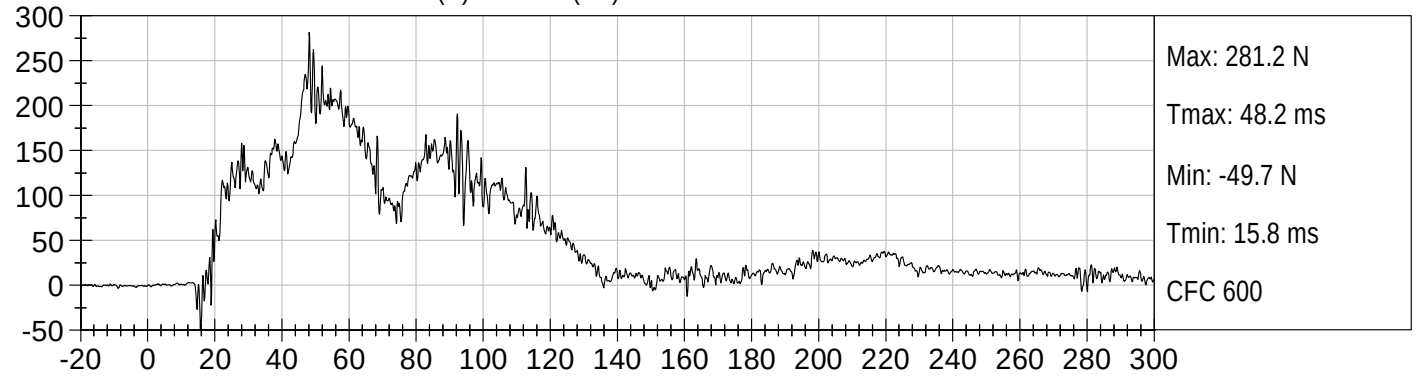
DRIVER LOWER RIB DISPLACEMENT - DEFLECTION RATE (m/s) vs TIME (ms)



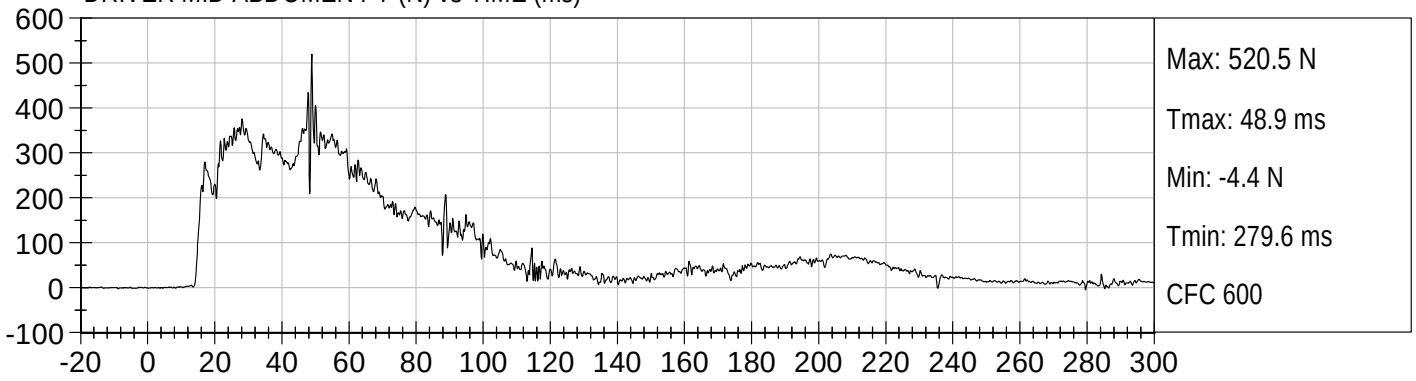
DRIVER LOWER RIB DISPLACEMENT (mm) vs TIME (ms)



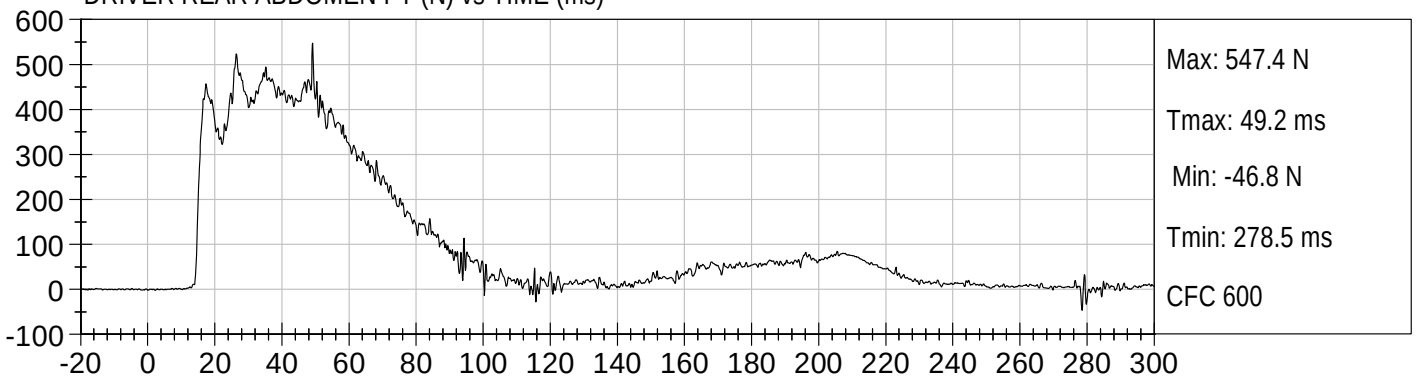
DRIVER FRONT ABDOMEN FY (N) vs TIME (ms)



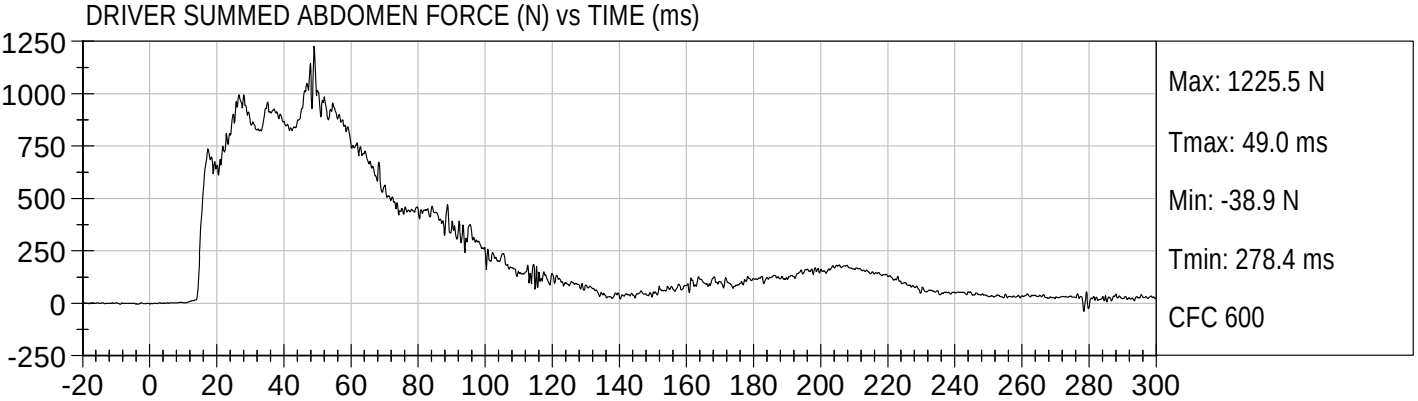
DRIVER MID ABDOMEN FY (N) vs TIME (ms)

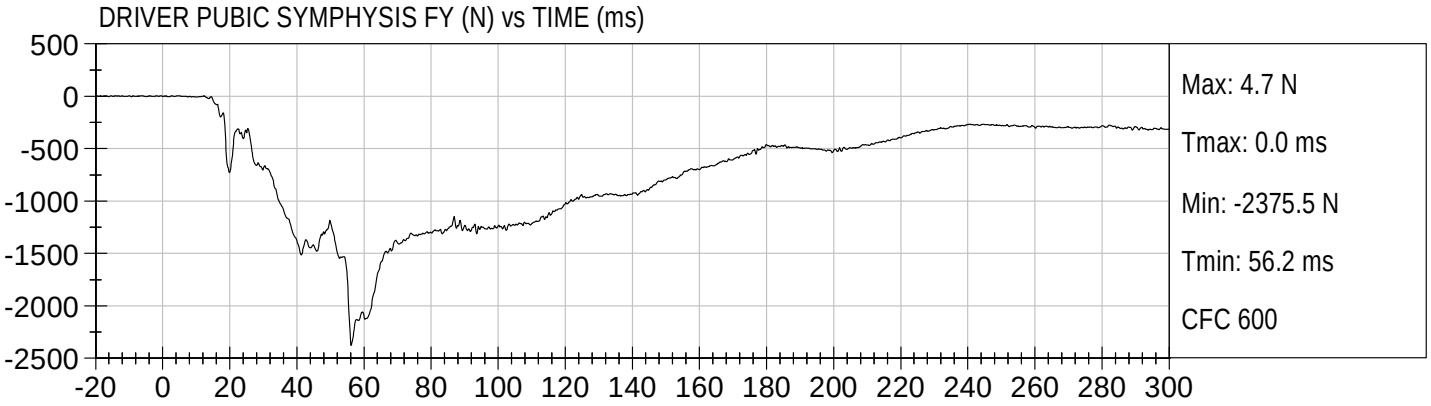


DRIVER REAR ABDOMEN FY (N) vs TIME (ms)



DRIVER SUMMED ABDOMEN FORCE (N) vs TIME (ms)




DRIVER PUBIC SYMPHYSIS FY (N) vs TIME (ms)
500
0
-500
-1000
-1500
-2000
-2500
-20
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
Max: 4.7 N
Tmax: 0.0 ms
Min: -2375.5 N
Tmin: 56.2 ms
CFC 600

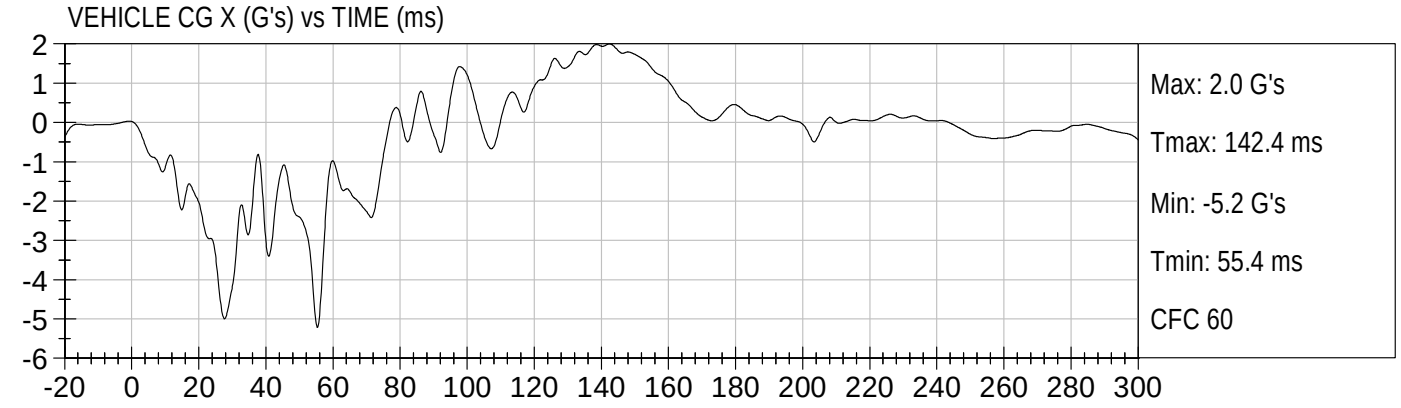
APPENDIX C

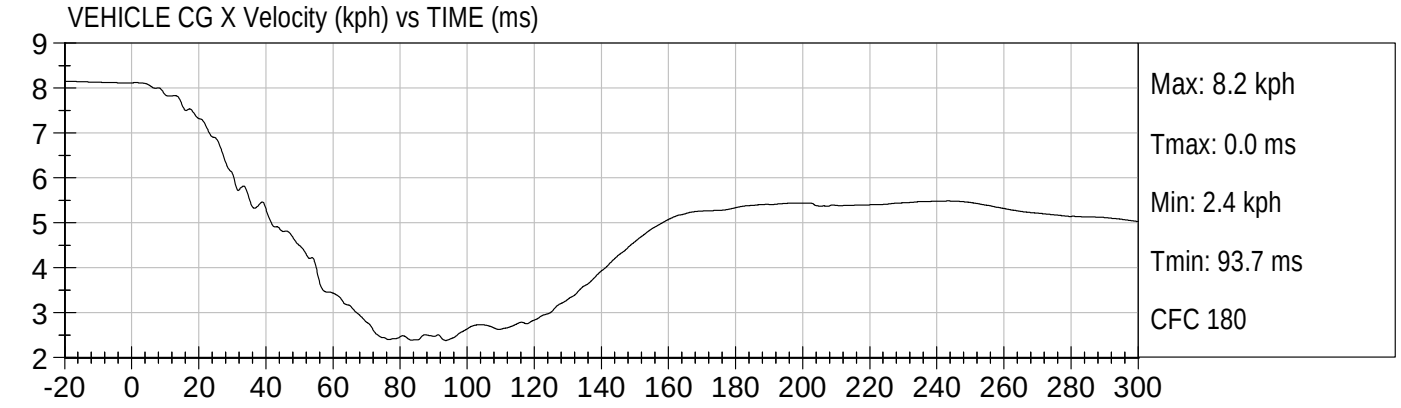
VEHICLE ACCELEROMETER RESPONSE DATA

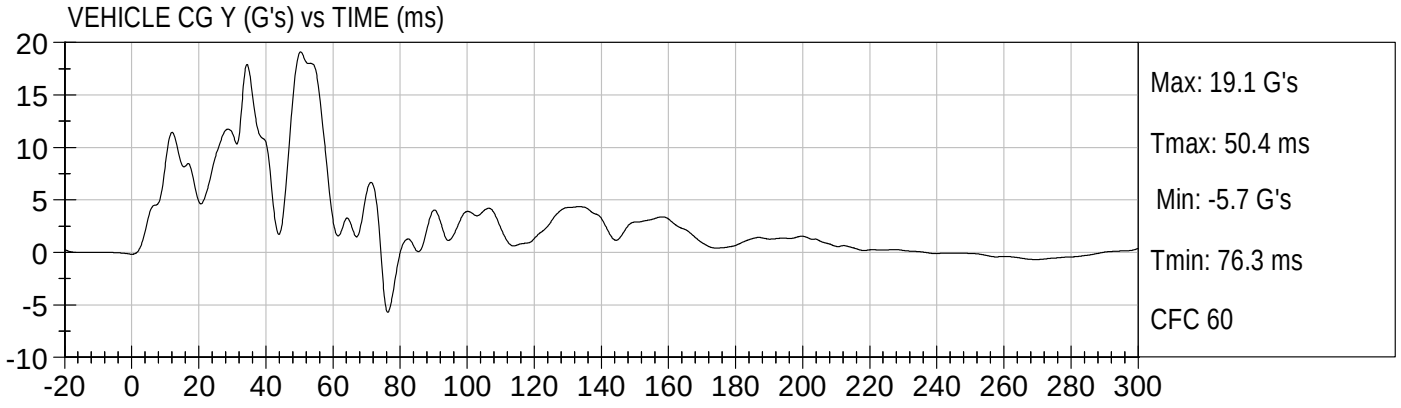
TABLE OF DATA PLOTS

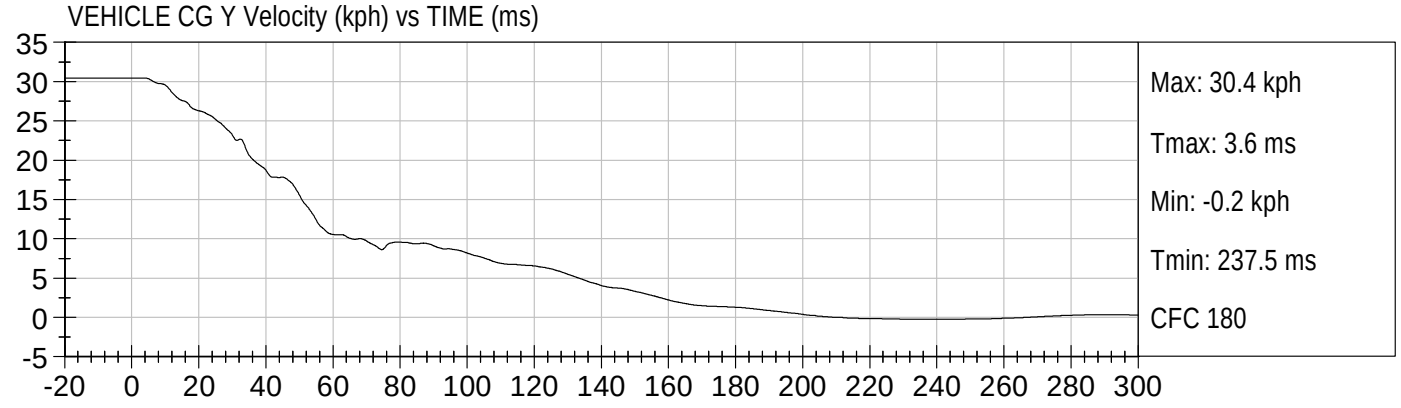
FMVSS 214 Rigid Pole Side Impact
2011 Kia Sorento - CB0511

Test Date: 04/04/2011
Speed: 19.6 mph (31.5 km/h)





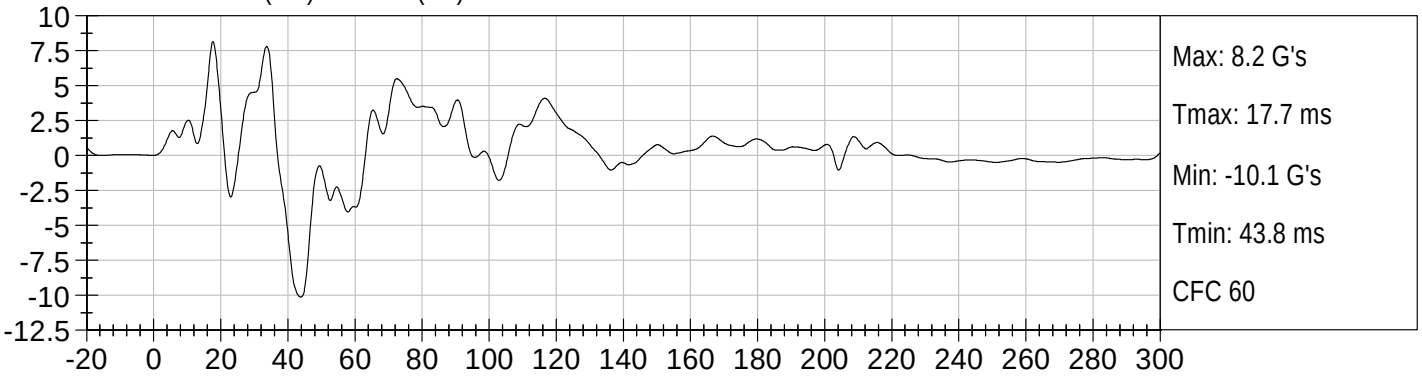




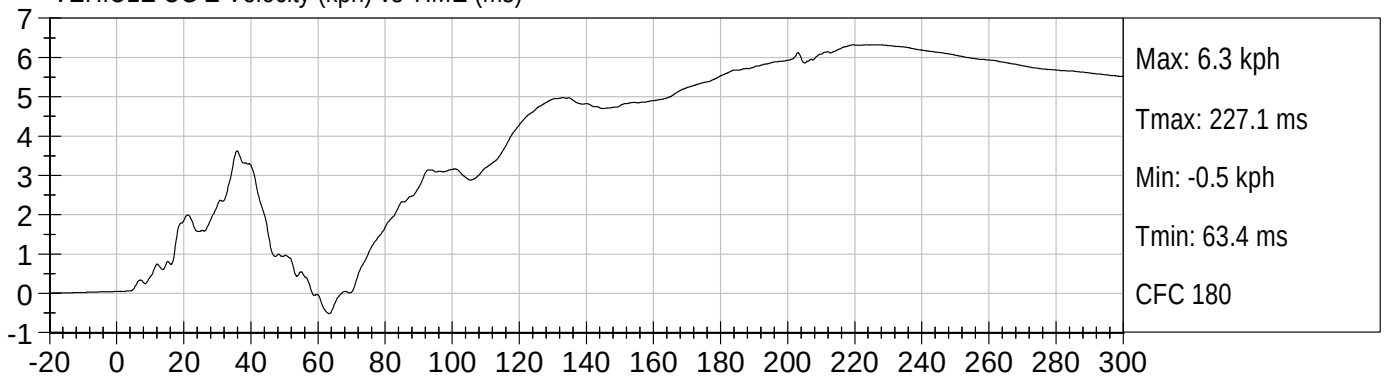
FMVSS 214 Rigid Pole Side Impact
2011 Kia Sorento - CB0511

Test Date: 04/04/2011
Speed: 19.6 mph (31.5 km/h)

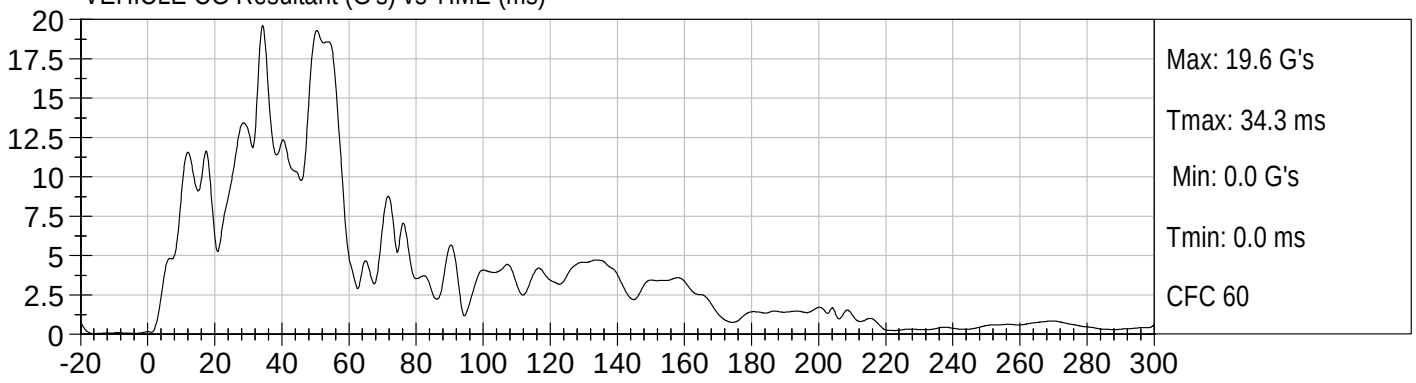
VEHICLE CG Z (G's) vs TIME (ms)



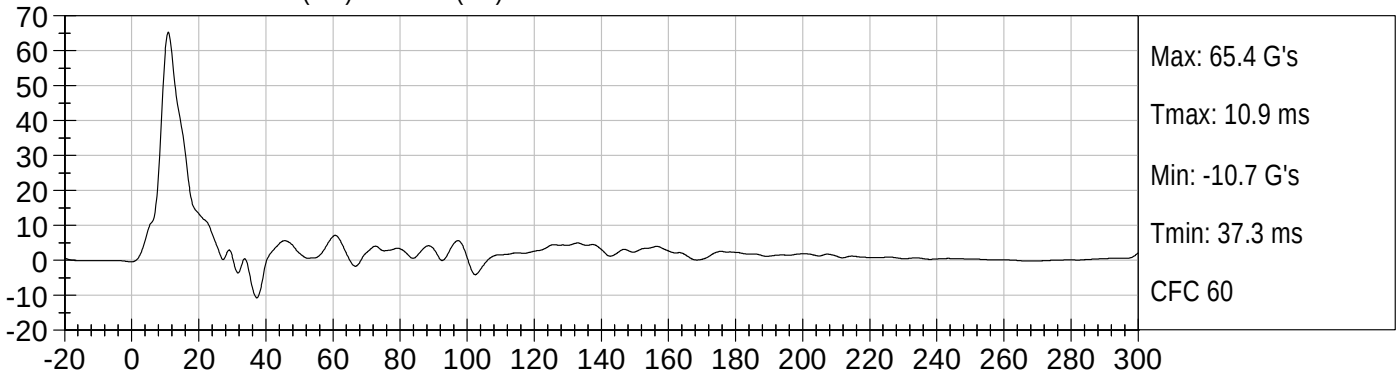
VEHICLE CG Z Velocity (kph) vs TIME (ms)



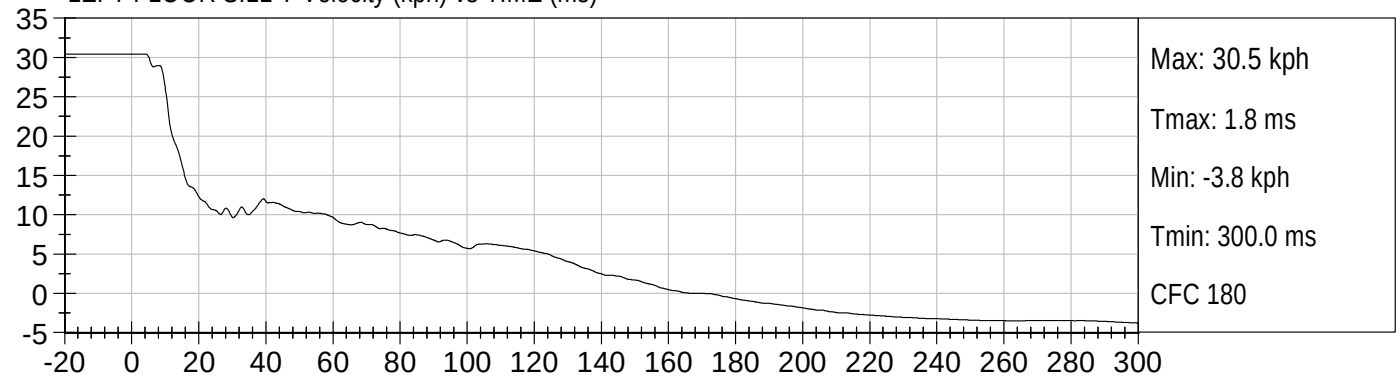
VEHICLE CG Resultant (G's) vs TIME (ms)



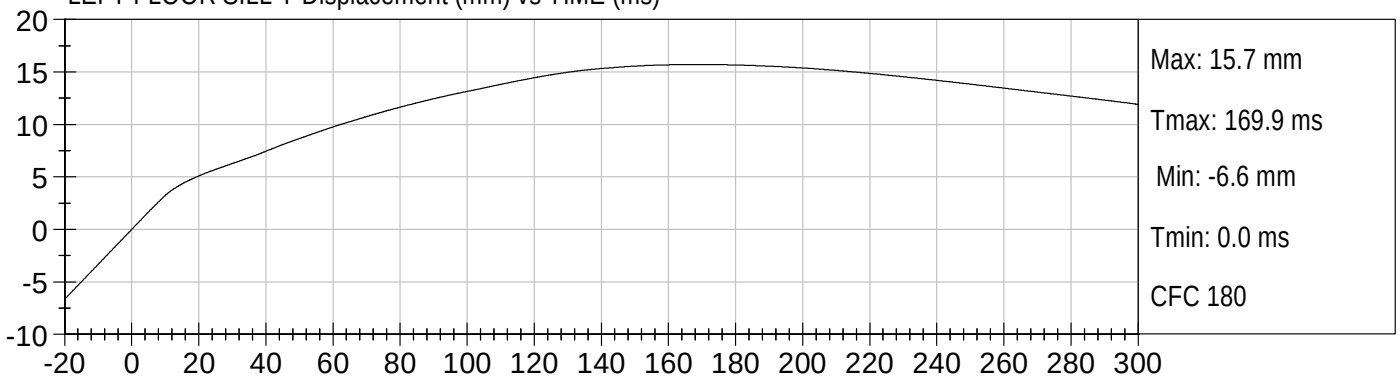
LEFT FLOOR SILL Y (G's) vs TIME (ms)



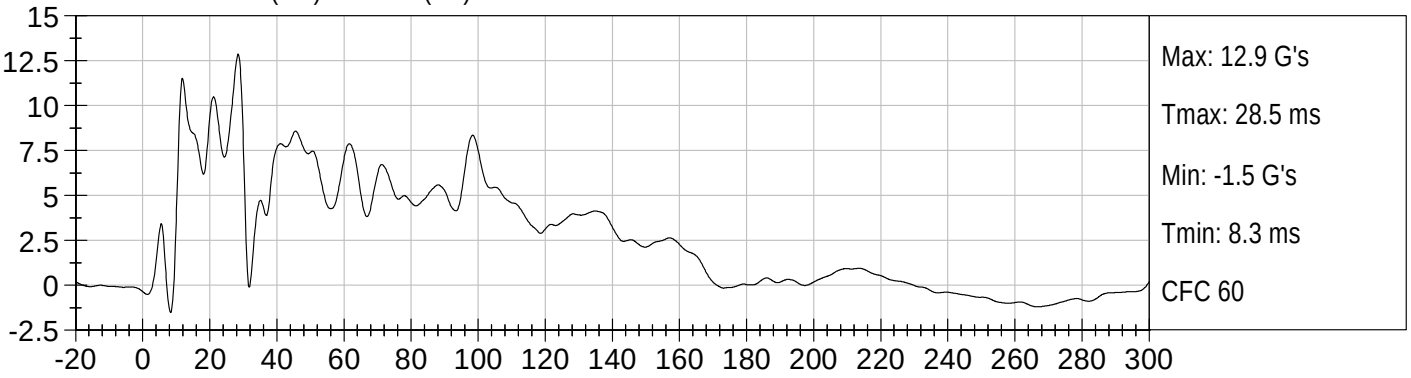
LEFT FLOOR SILL Y Velocity (kph) vs TIME (ms)



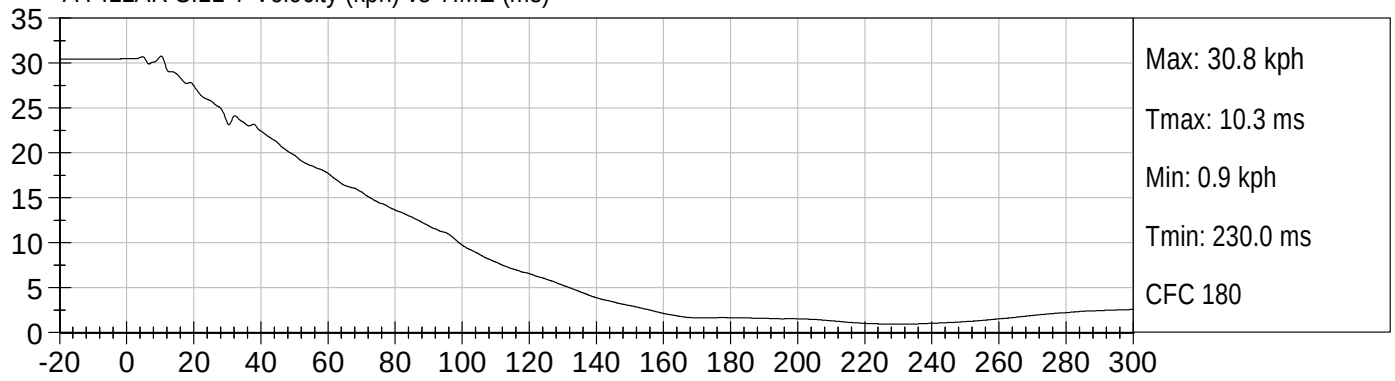
LEFT FLOOR SILL Y Displacement (mm) vs TIME (ms)



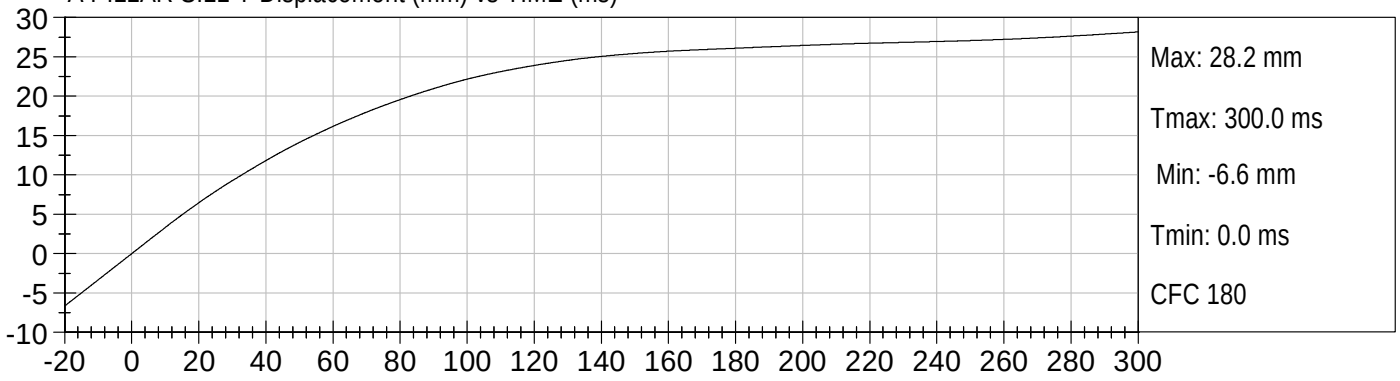
A PILLAR SILL Y (G's) vs TIME (ms)



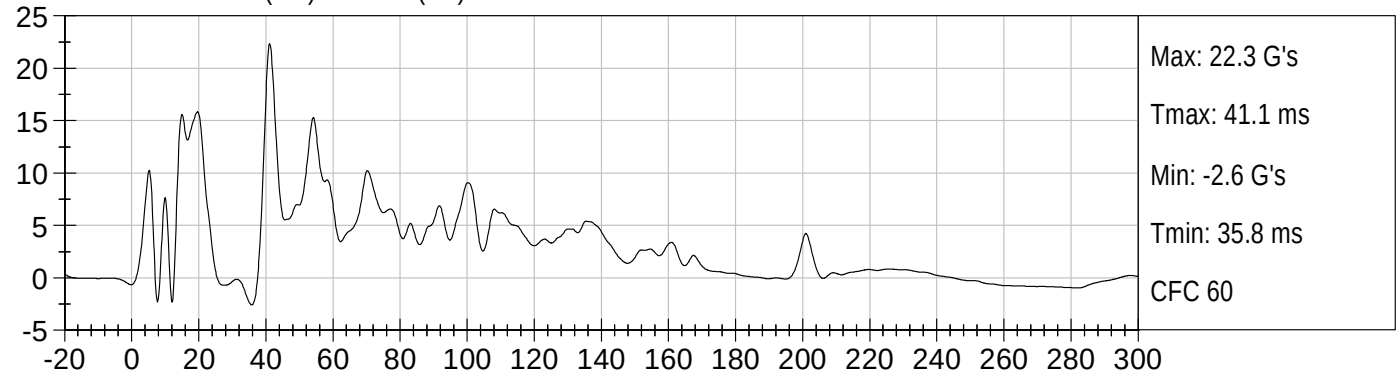
A PILLAR SILL Y Velocity (kph) vs TIME (ms)



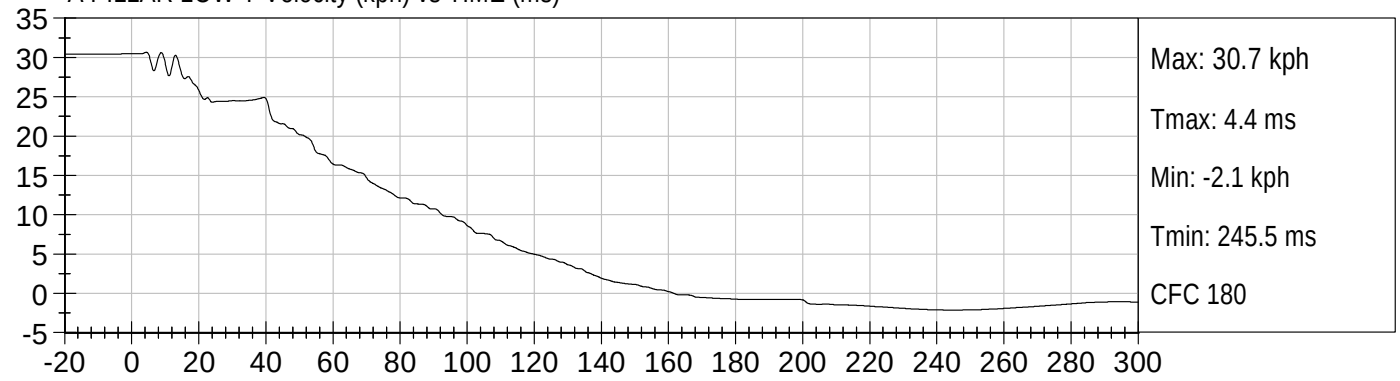
A PILLAR SILL Y Displacement (mm) vs TIME (ms)



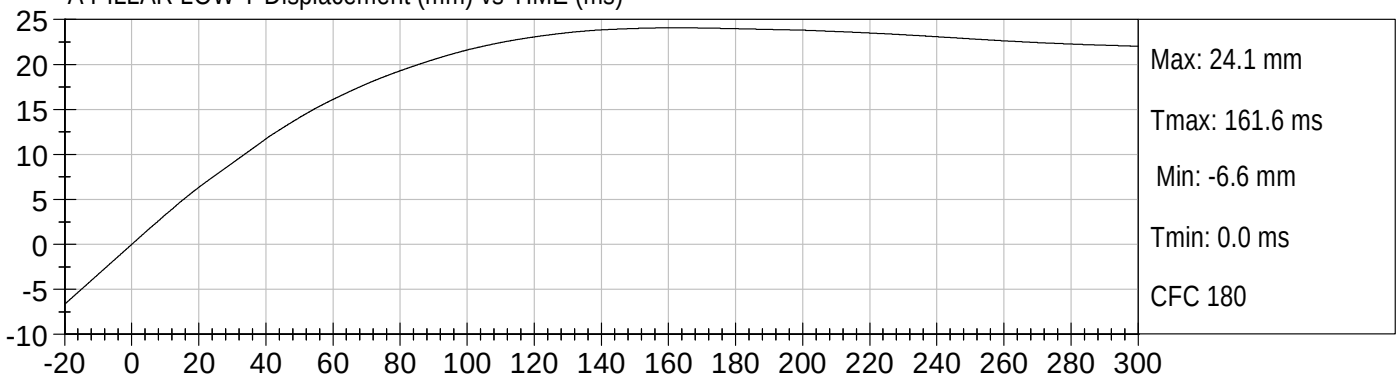
A PILLAR LOW Y (G's) vs TIME (ms)



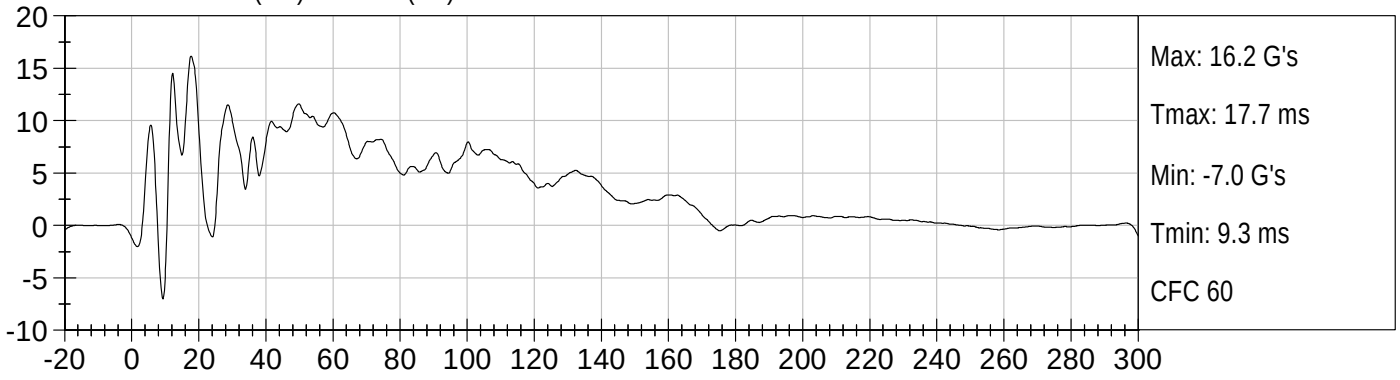
A PILLAR LOW Y Velocity (kph) vs TIME (ms)



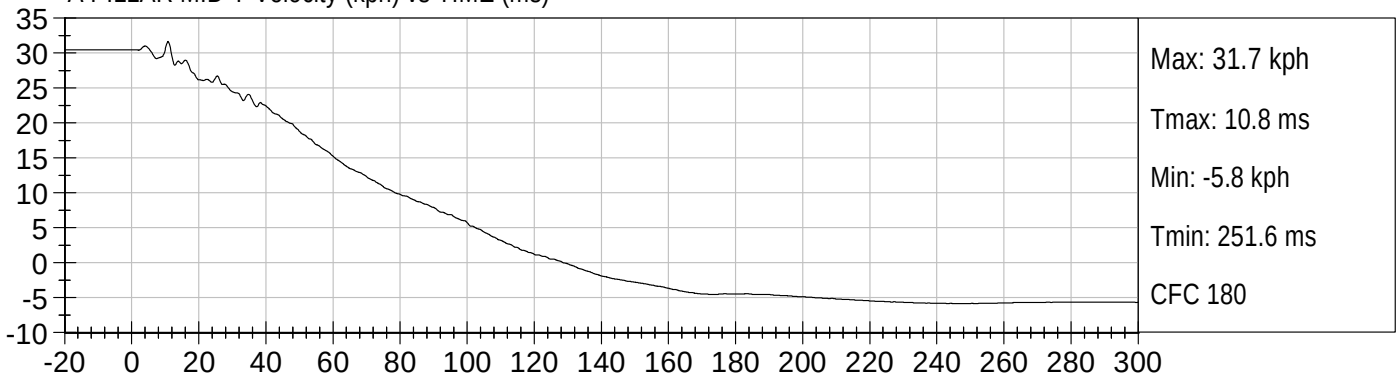
A PILLAR LOW Y Displacement (mm) vs TIME (ms)



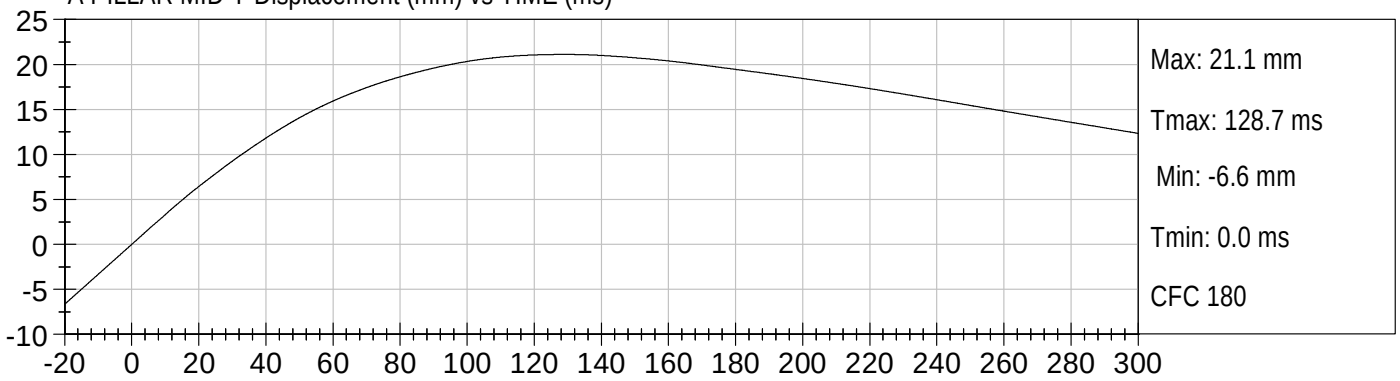
A PILLAR MID Y (G's) vs TIME (ms)



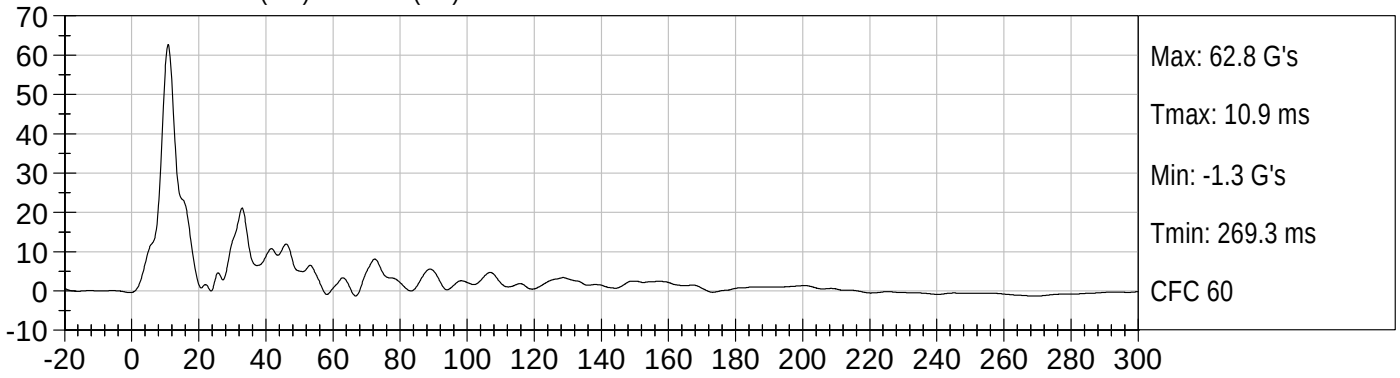
A PILLAR MID Y Velocity (kph) vs TIME (ms)



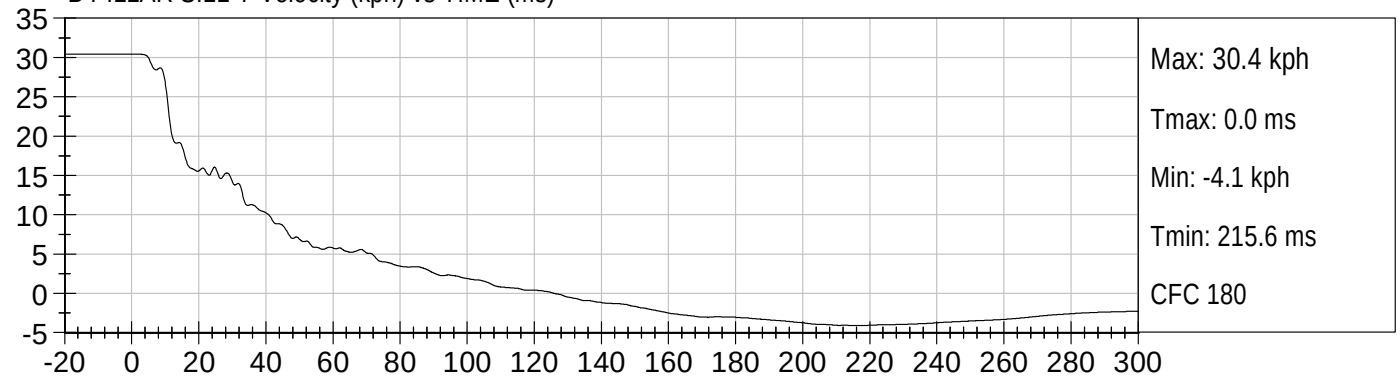
A PILLAR MID Y Displacement (mm) vs TIME (ms)



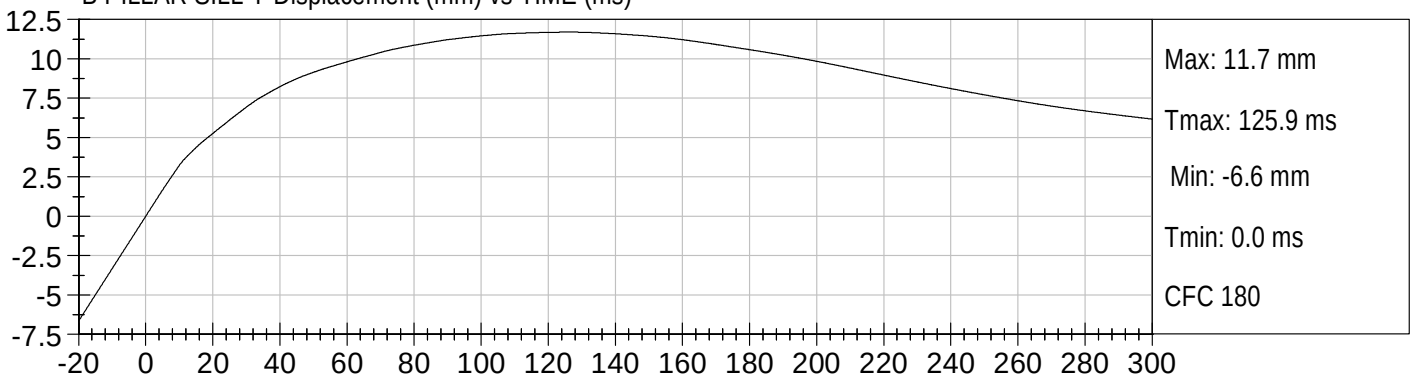
B PILLAR SILL Y (G's) vs TIME (ms)



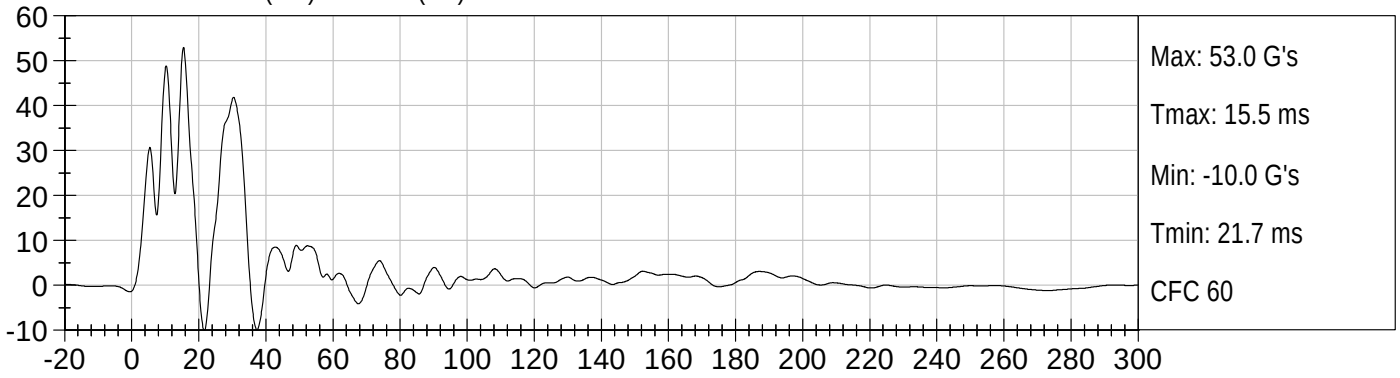
B PILLAR SILL Y Velocity (kph) vs TIME (ms)



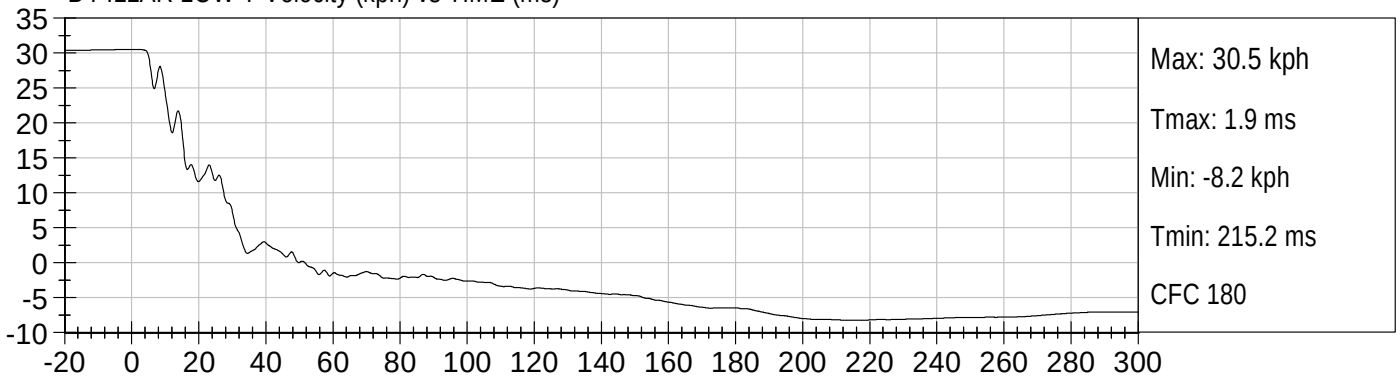
B PILLAR SILL Y Displacement (mm) vs TIME (ms)



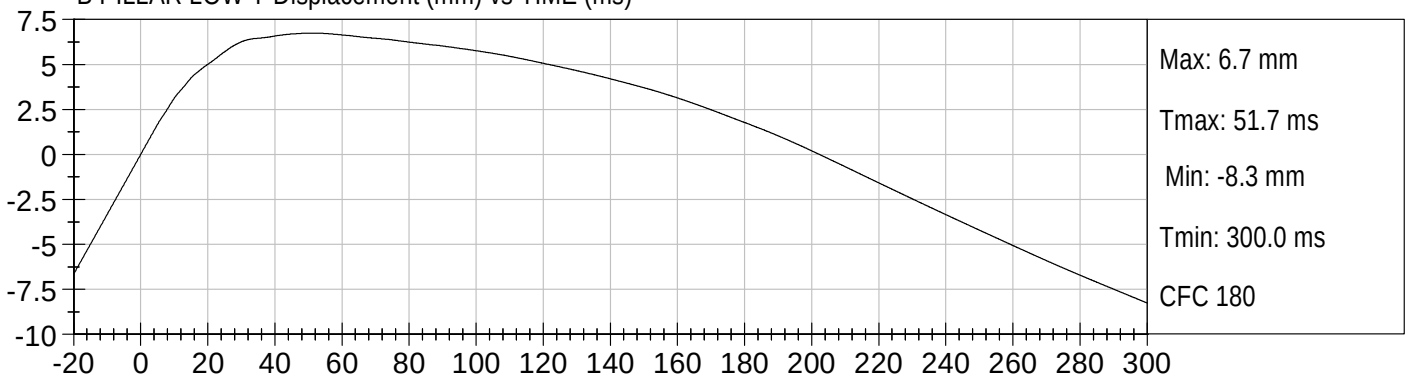
B PILLAR LOW Y (G's) vs TIME (ms)



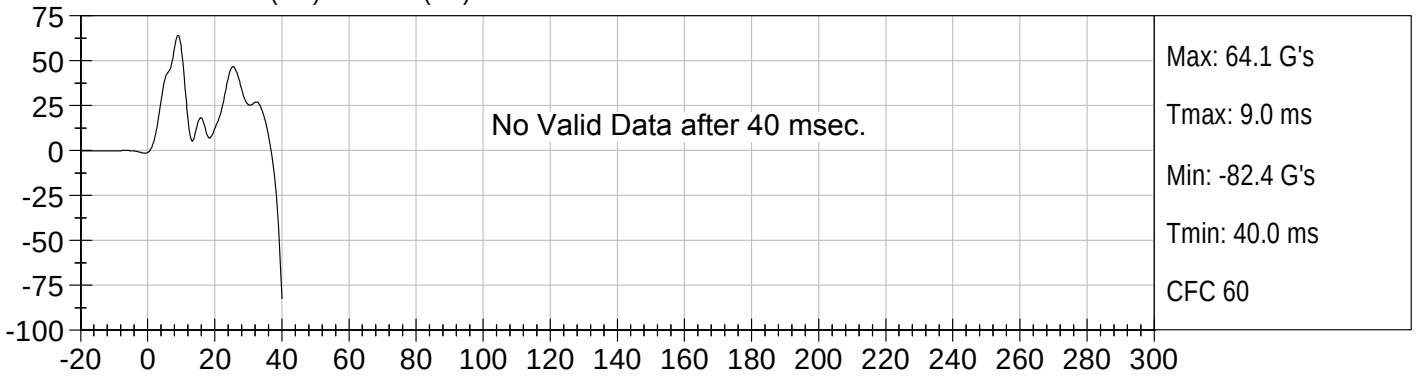
B PILLAR LOW Y Velocity (kph) vs TIME (ms)



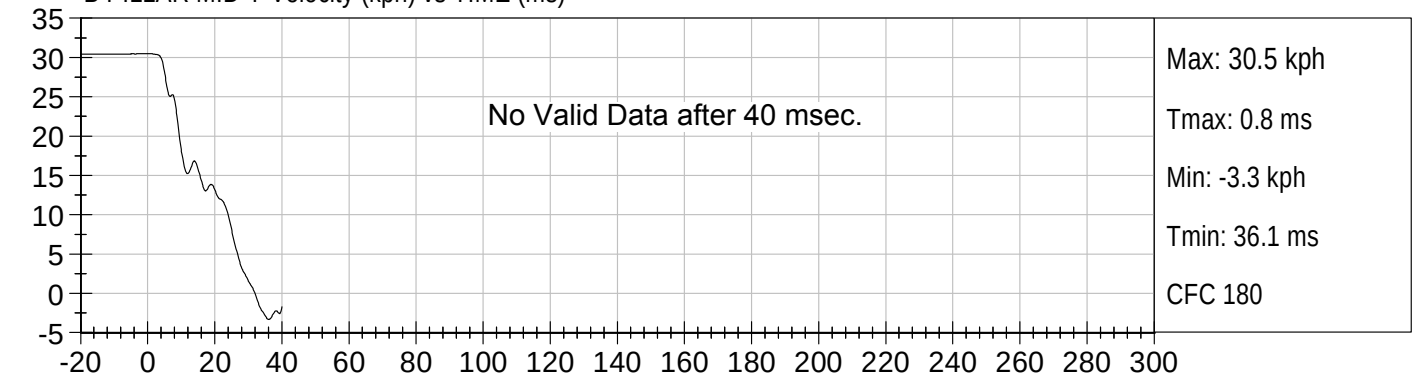
B PILLAR LOW Y Displacement (mm) vs TIME (ms)



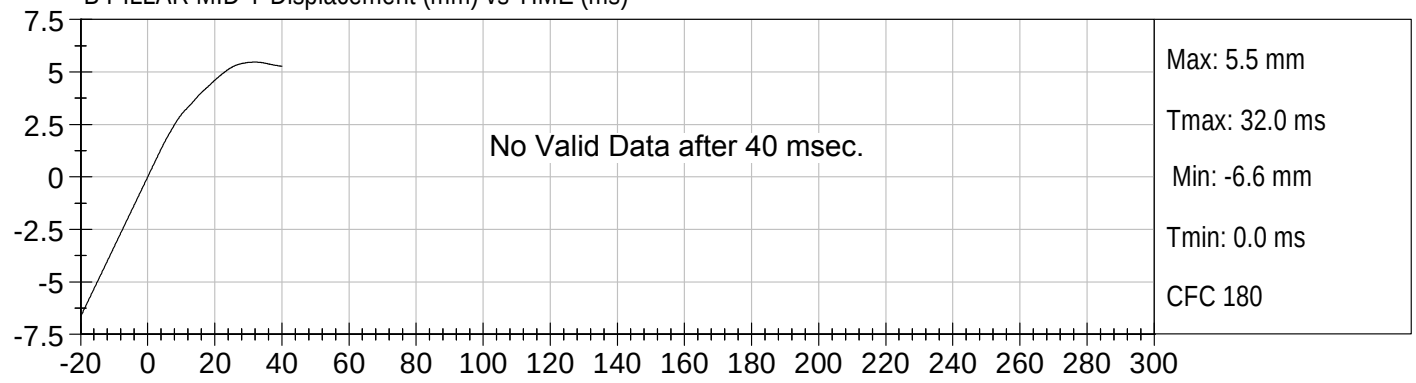
B PILLAR MID Y (G's) vs TIME (ms)



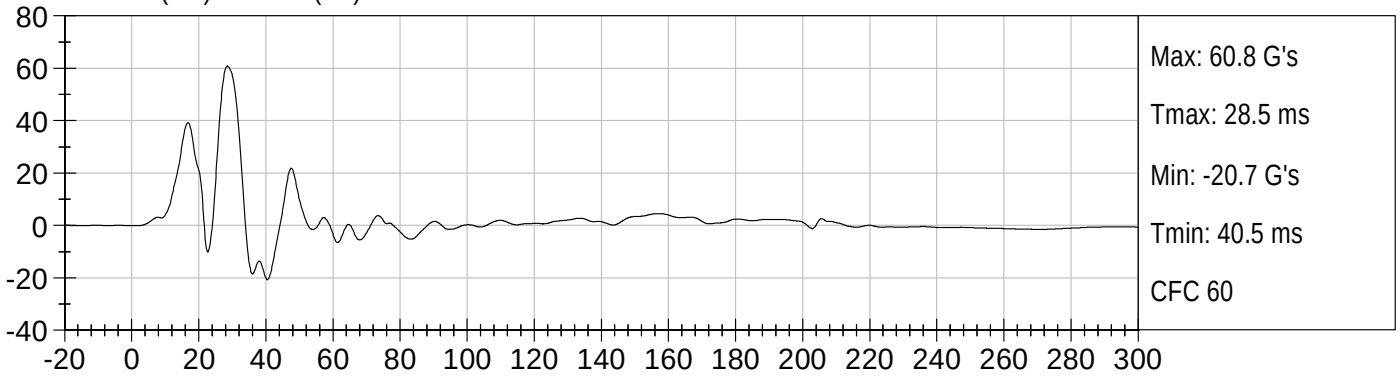
B PILLAR MID Y Velocity (kph) vs TIME (ms)



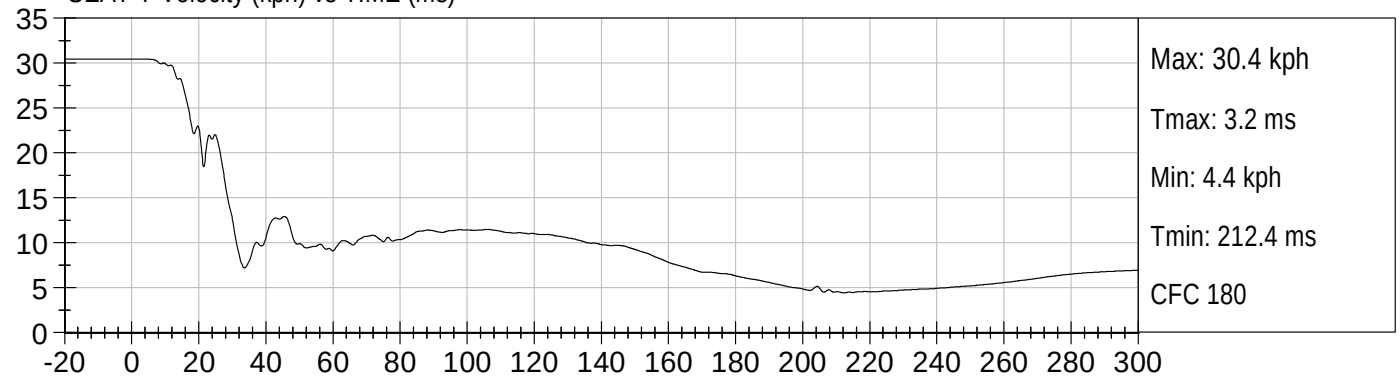
B PILLAR MID Y Displacement (mm) vs TIME (ms)



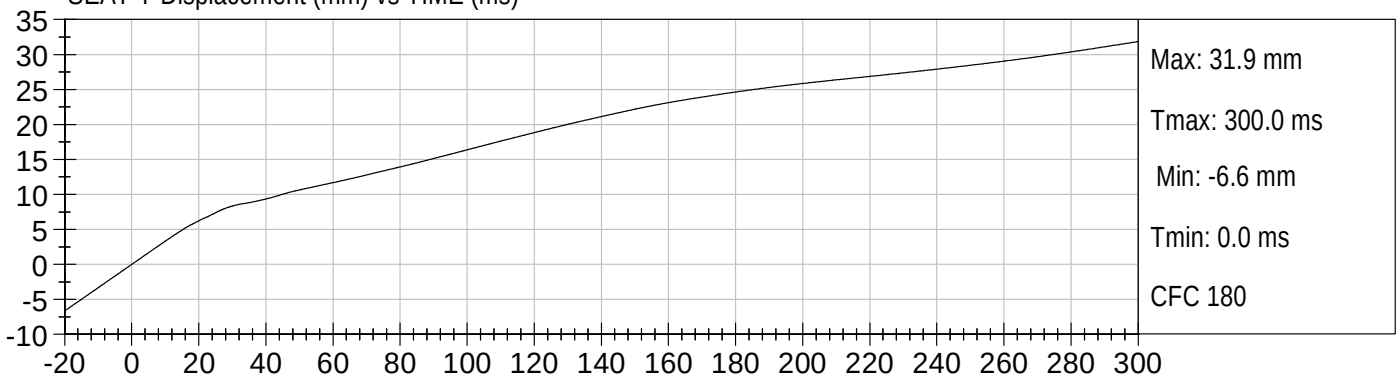
SEAT Y (G's) vs TIME (ms)



SEAT Y Velocity (kph) vs TIME (ms)



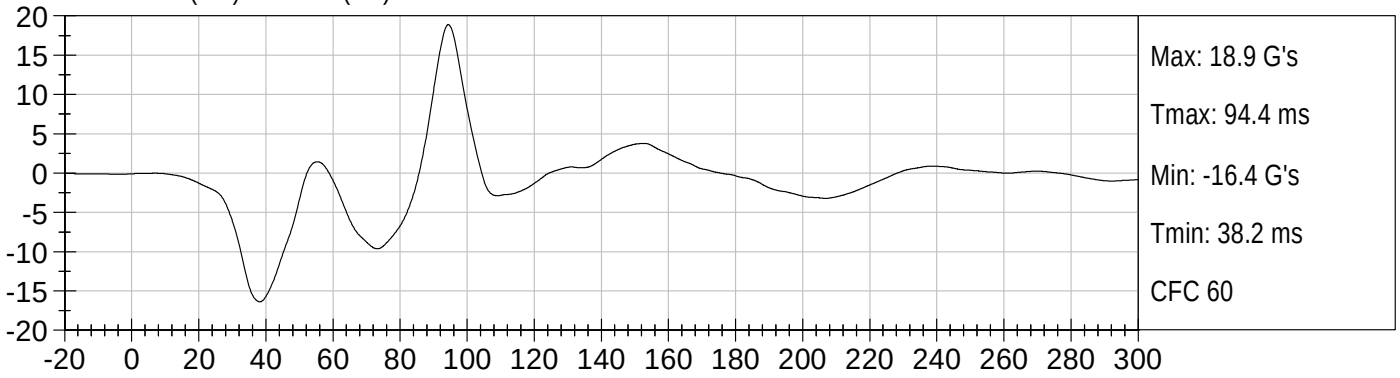
SEAT Y Displacement (mm) vs TIME (ms)



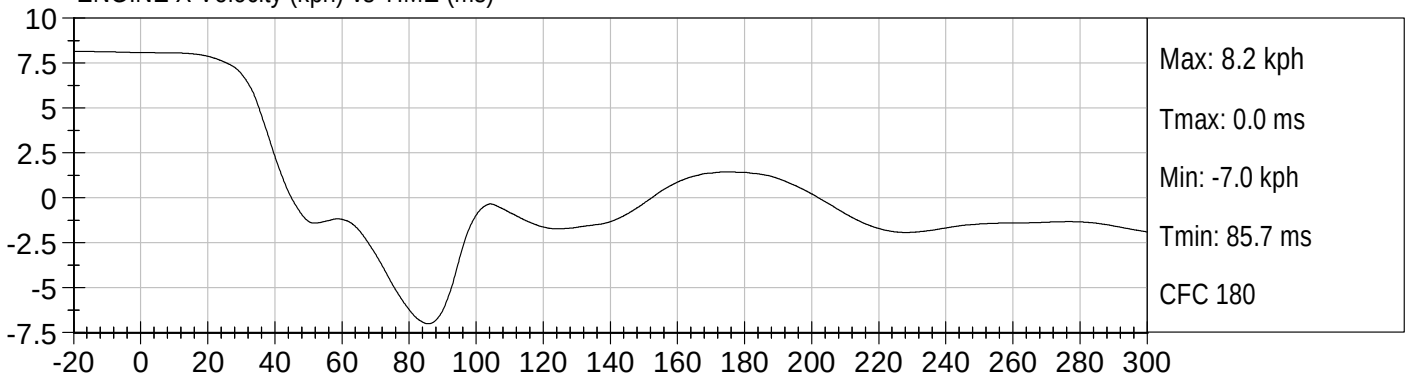
FMVSS 214 Rigid Pole Side Impact
2011 Kia Sorento - CB0511

Test Date: 04/04/2011
Speed: 19.6 mph (31.5 km/h)

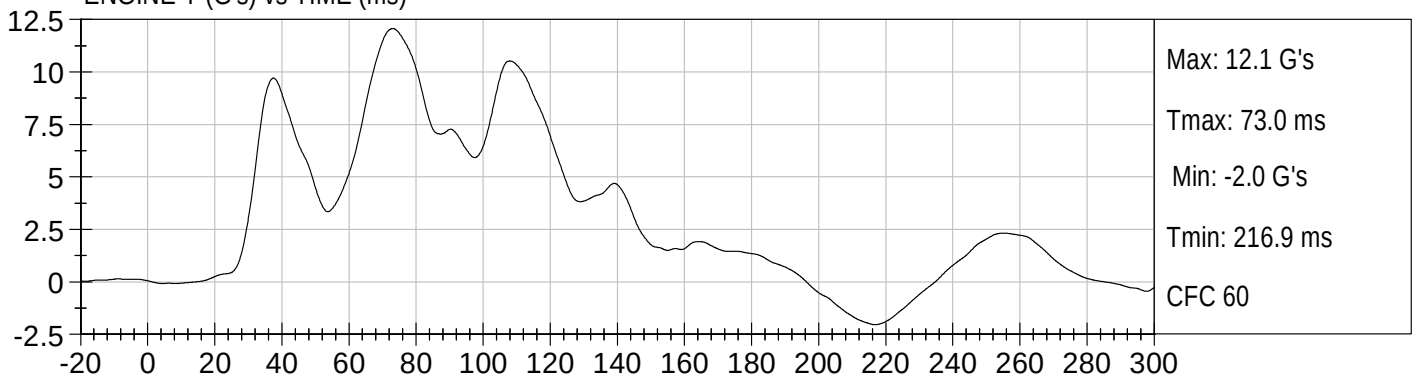
ENGINE X (G's) vs TIME (ms)



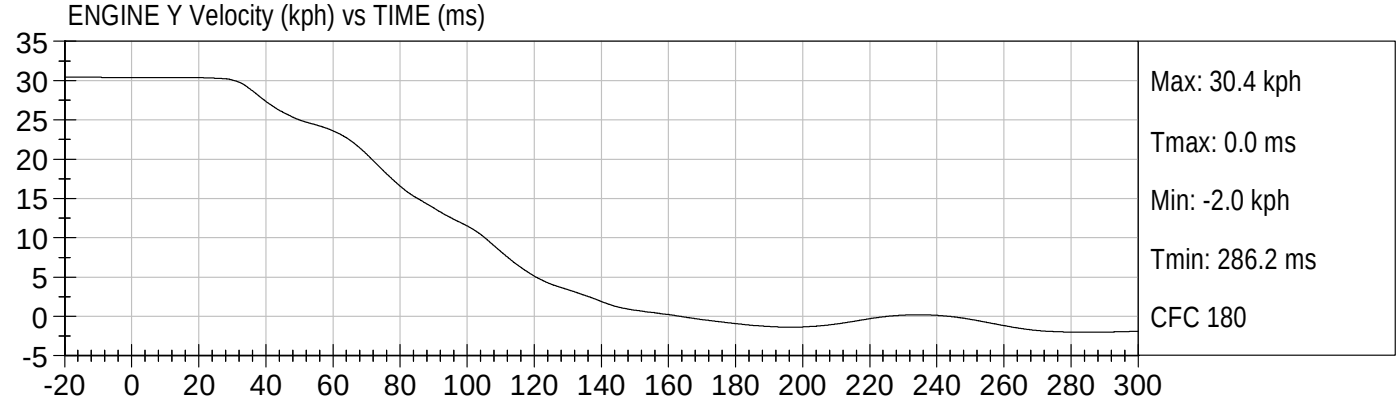
ENGINE X Velocity (kph) vs TIME (ms)



ENGINE Y (G's) vs TIME (ms)



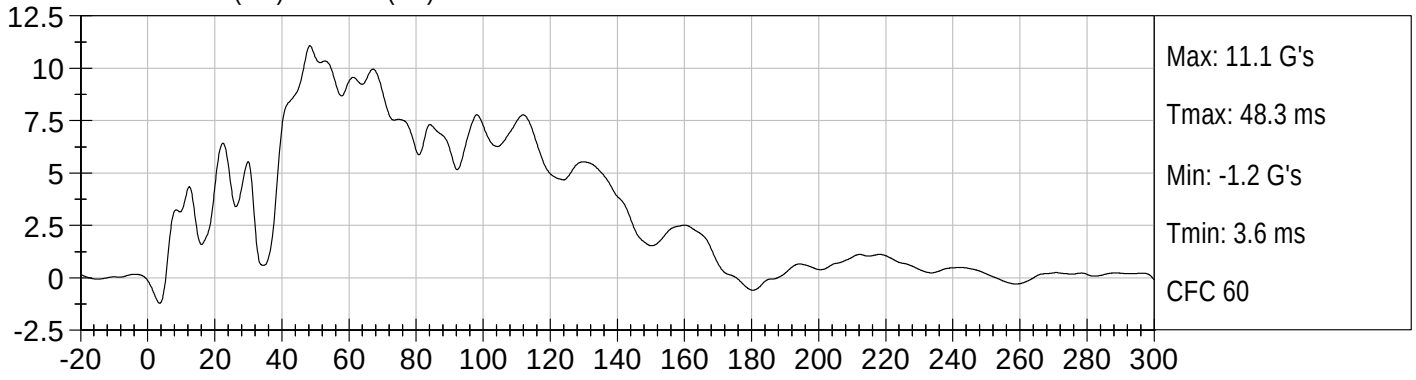
ENGINE Y Velocity (kph) vs TIME (ms)



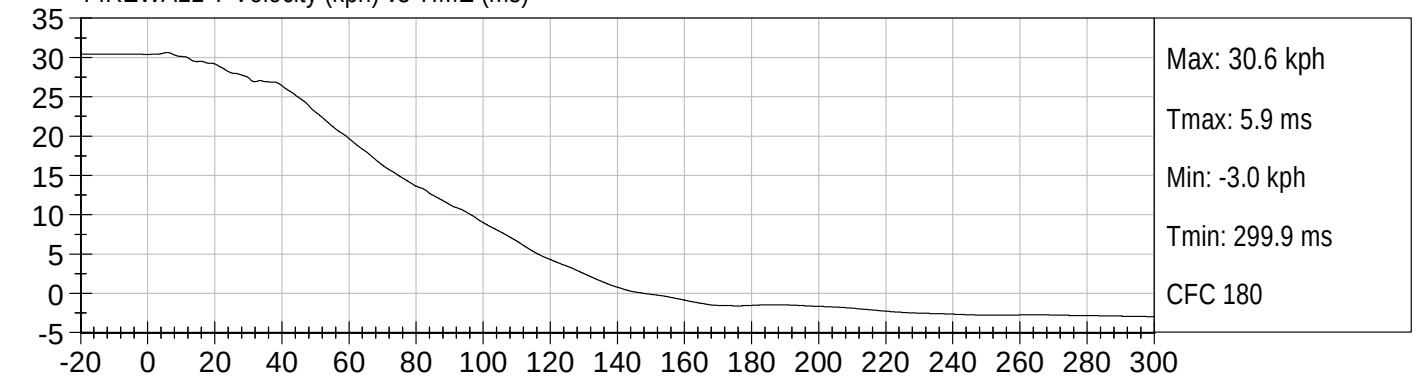
FMVSS 214 Rigid Pole Side Impact
2011 Kia Sorento - CB0511

Test Date: 04/04/2011
Speed: 19.6 mph (31.5 km/h)

FIREWALL Y (G's) vs TIME (ms)



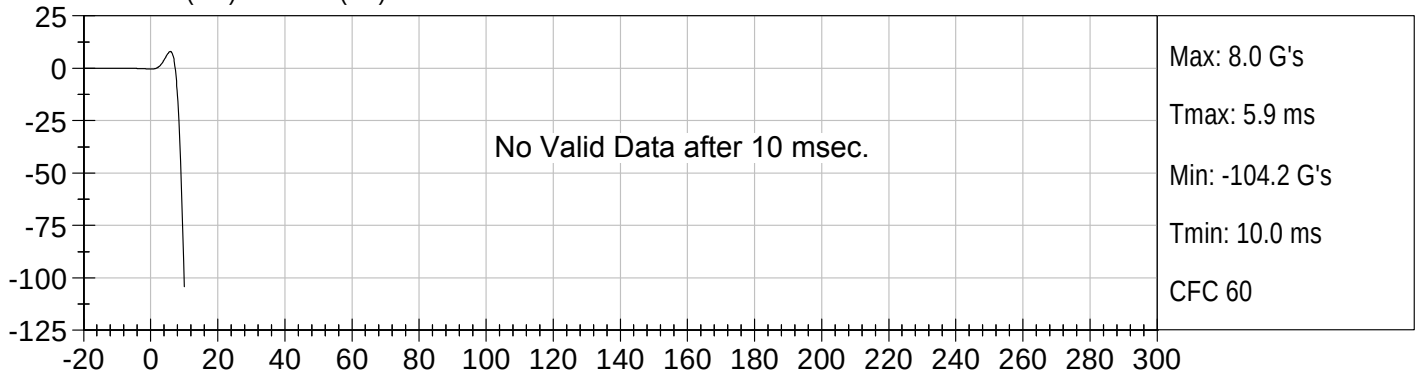
FIREWALL Y Velocity (kph) vs TIME (ms)



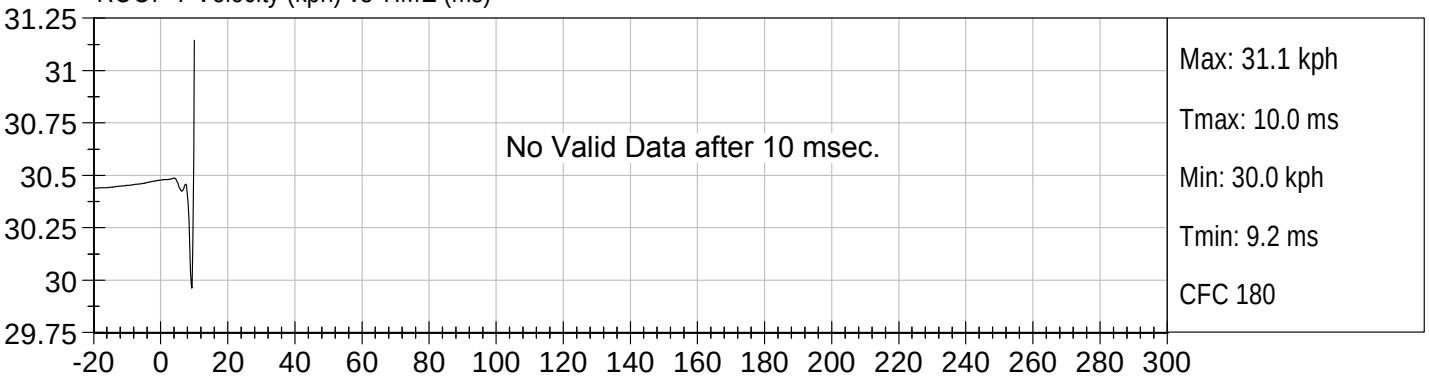
FMVSS 214 Rigid Pole Side Impact
2011 Kia Sorento - CB0511

Test Date: 04/04/2011
Speed: 19.6 mph (31.5 km/h)

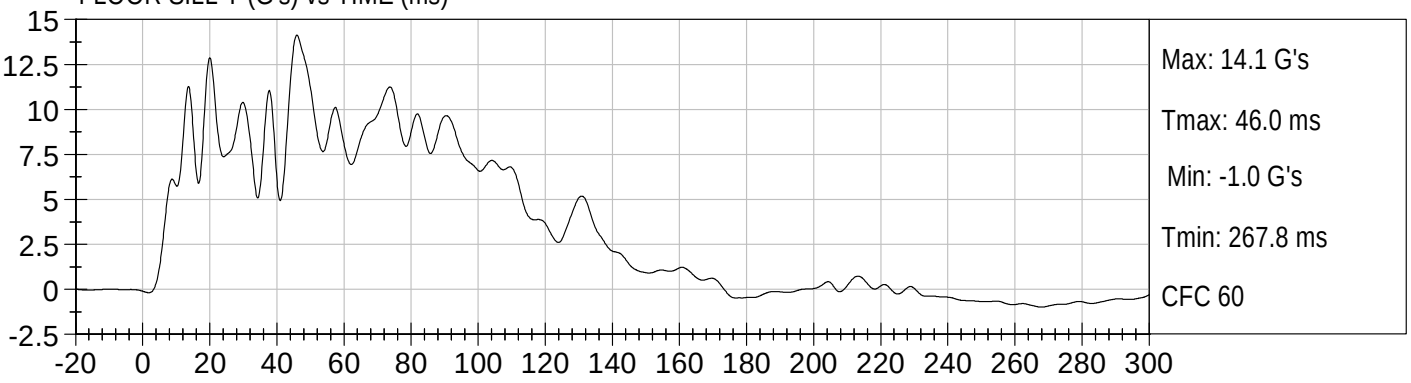
ROOF Y (G's) vs TIME (ms)



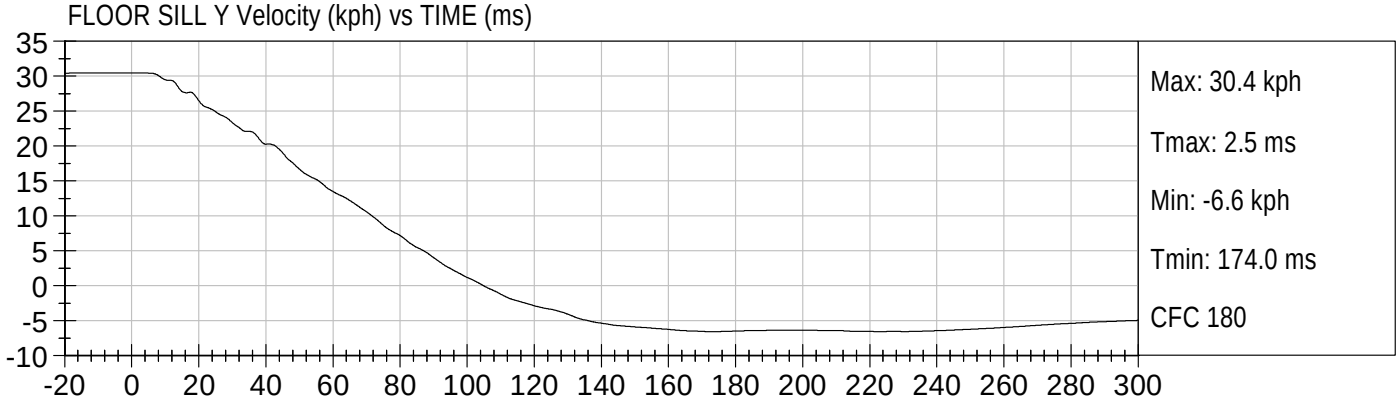
ROOF Y Velocity (kph) vs TIME (ms)



FLOOR SILL Y (G's) vs TIME (ms)



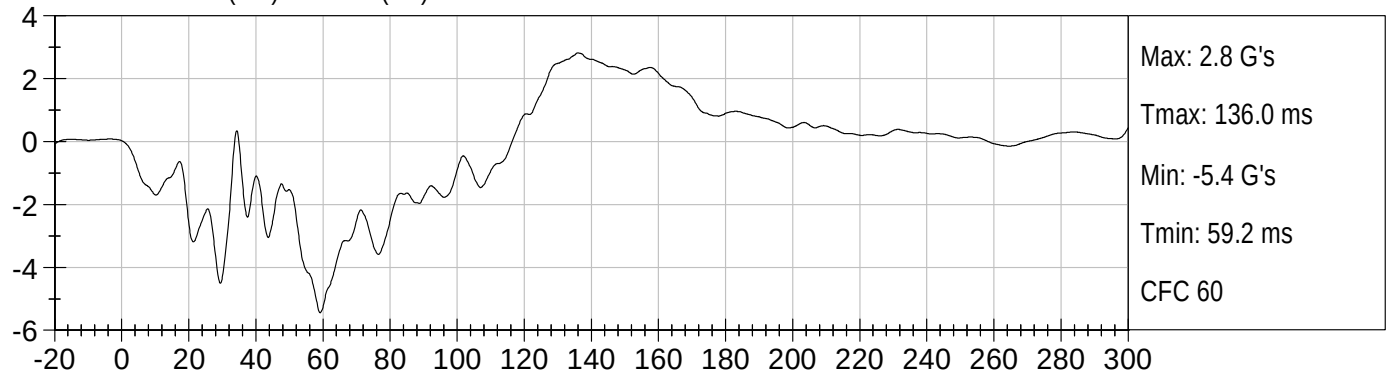
FLOOR SILL Y Velocity (kph) vs TIME (ms)



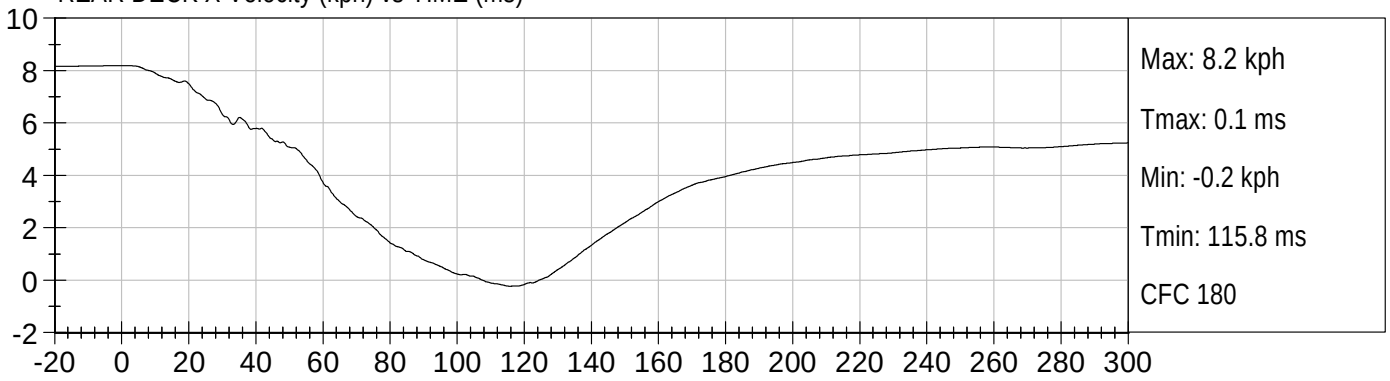
FMVSS 214 Rigid Pole Side Impact
2011 Kia Sorento - CB0511

Test Date: 04/04/2011
Speed: 19.6 mph (31.5 km/h)

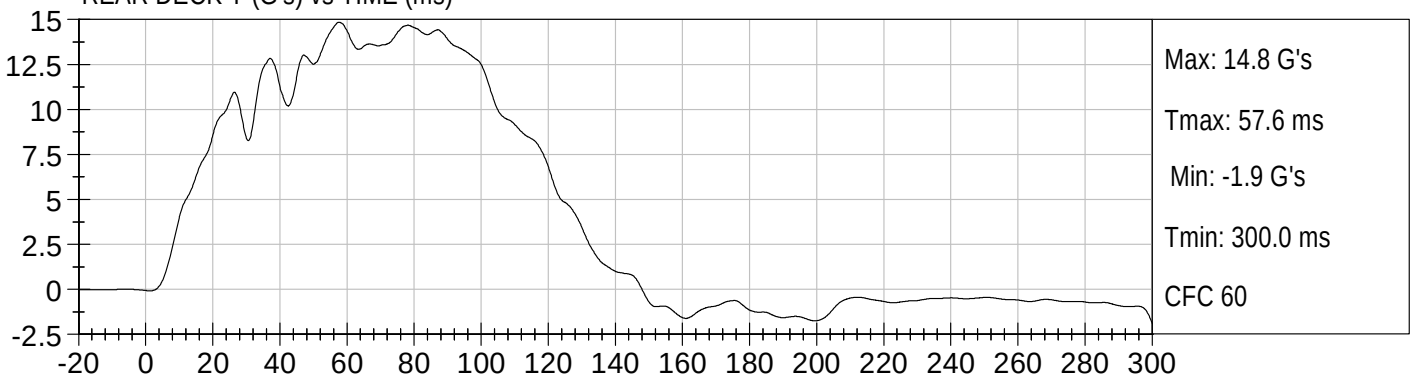
REAR DECK X (G's) vs TIME (ms)



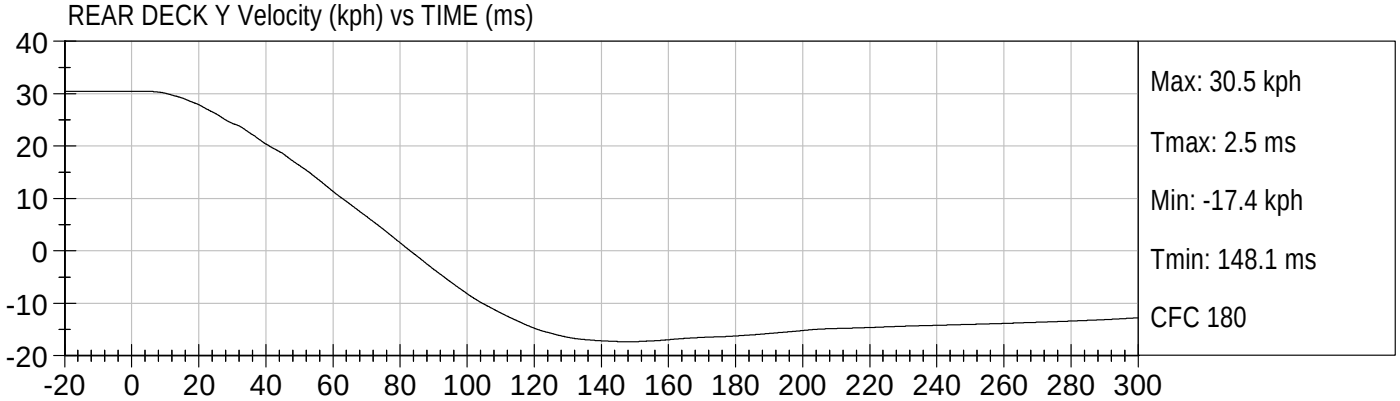
REAR DECK X Velocity (kph) vs TIME (ms)



REAR DECK Y (G's) vs TIME (ms)



REAR DECK Y Velocity (kph) vs TIME (ms)



APPENDIX D

DUMMY PERFORMANCE CALIBRATION TEST DATA

MGA RESEARCH CORPORATION

HEAD DROP TEST

ES-2re DUMMY

ATD Serial No: 016 **Test ID:** D111261

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	22.1	Pass
Laboratory Relative Humidity	%	10 to 70	26	Pass
Peak Resultant Acceleration	G's	125 to 155	151	Pass
Peak Lateral Acceleration	G's	+/- 15	-8.1	Pass
Unimodal	N/A	Yes	Yes	Pass
Oscillations	N/A	within 15% of peak	Yes	Pass
		Overall Test Results		Pass

Jessica Hall
Laboratory Technician

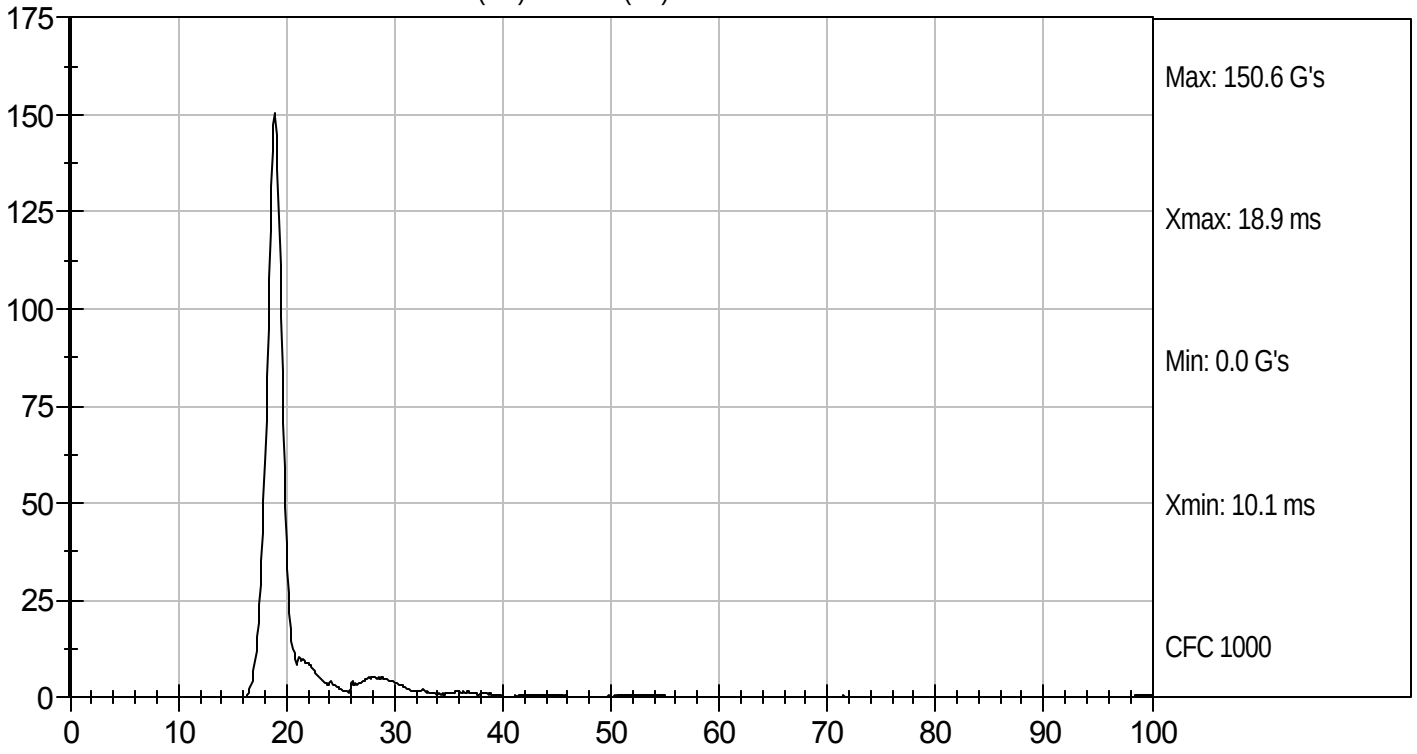
4/1/11
Test Date

David Winkelbauer
Approved By

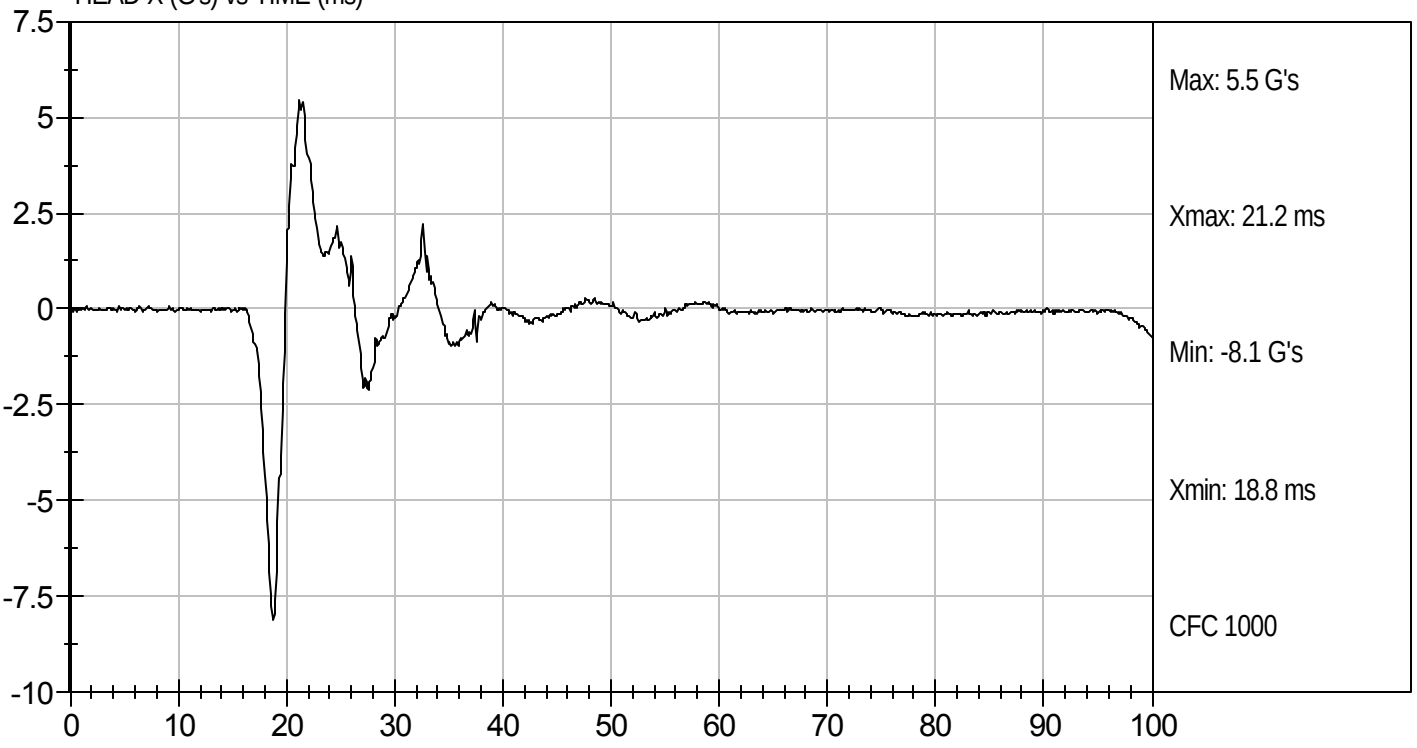
Test Desc: Head Drop
Component ID: D111261

Test Date: 4/1/11
Velocity: 0 ft/s, 0 m/s

PEAK RESULTANT ACCELERATION (G's) vs TIME (ms)



HEAD X (G's) vs TIME (ms)



MGA RESEARCH CORPORATION

NECK PENDULUM TEST

ES-2re DUMMY

ATD Serial No: 016 **Test I.D:** D111262

Tested Parameter		Units	Specification	Result	Pass/Fail
Laboratory Temperature		deg C	18.0 to 22.0	22.0	Pass
Laboratory Relative Humidity		%	10 to 70	26	Pass
Pendulum Speed		m/s	3.3 to 3.5	3.5	Pass
Pendulum Deceleration	1 ms	m/s	0.00 to -0.05	-0.02	Pass
	3 ms	m/s	-0.25 to -0.375	-0.33	Pass
	14 ms	m/s	-3.20 to -3.70	-3.41	Pass
Maximum Flexion Angle		deg	49.0 to 59.0	50.9	Pass
Time of Maximum Flexion Angle		ms	54.0 to 66.0	60.2	Pass
Head Rotation Decay Time to 0 degree		ms	53.0 to 88.0	59.7	Pass
			Overall Test Results		Pass

Jessica Hall
Laboratory Technician

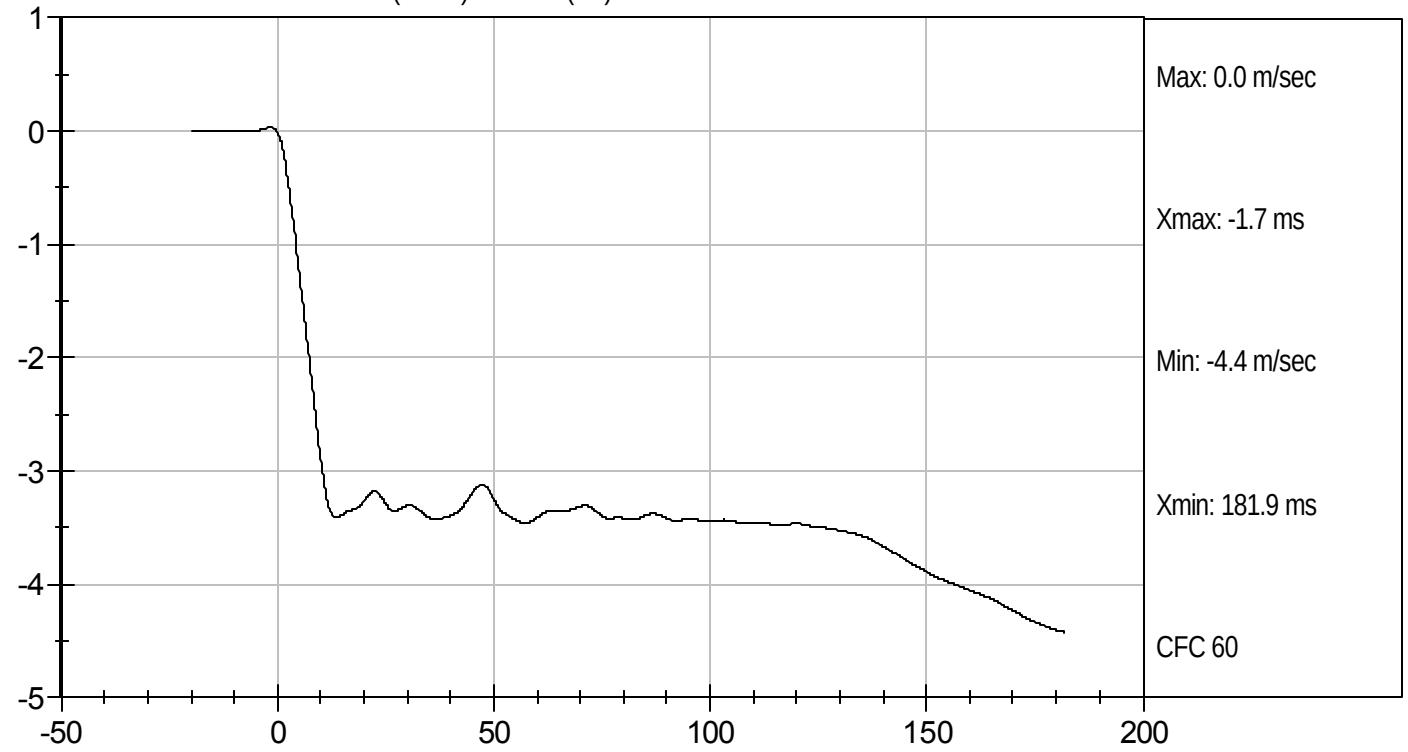
4/1/11
Test Date

David Winkelbauer
Approved By

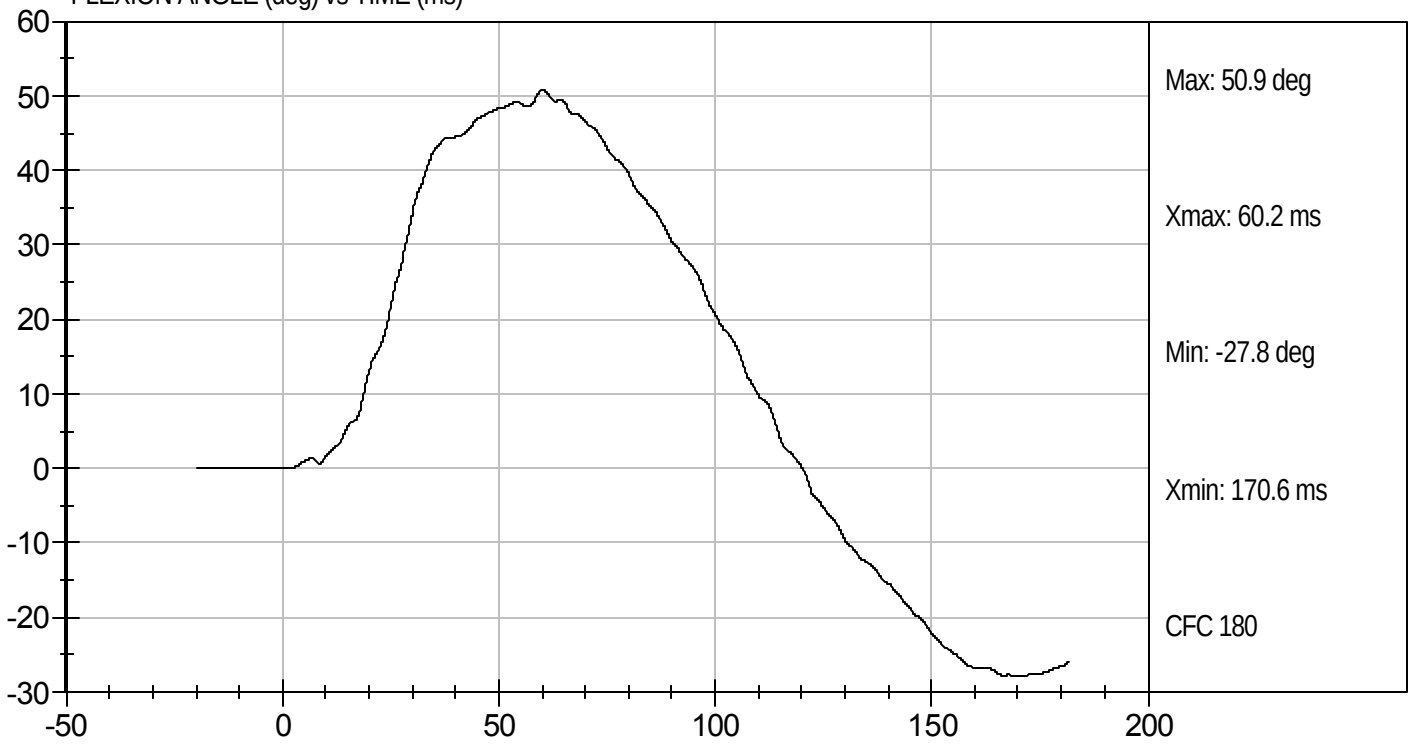
Test Desc: Neck Bending
Component ID: D111262

Test Date: 4/1/11
Velocity: 11.34 ft/s, 3.5 m/s

PENDULUM DECELERATION (m/sec) vs TIME (ms)

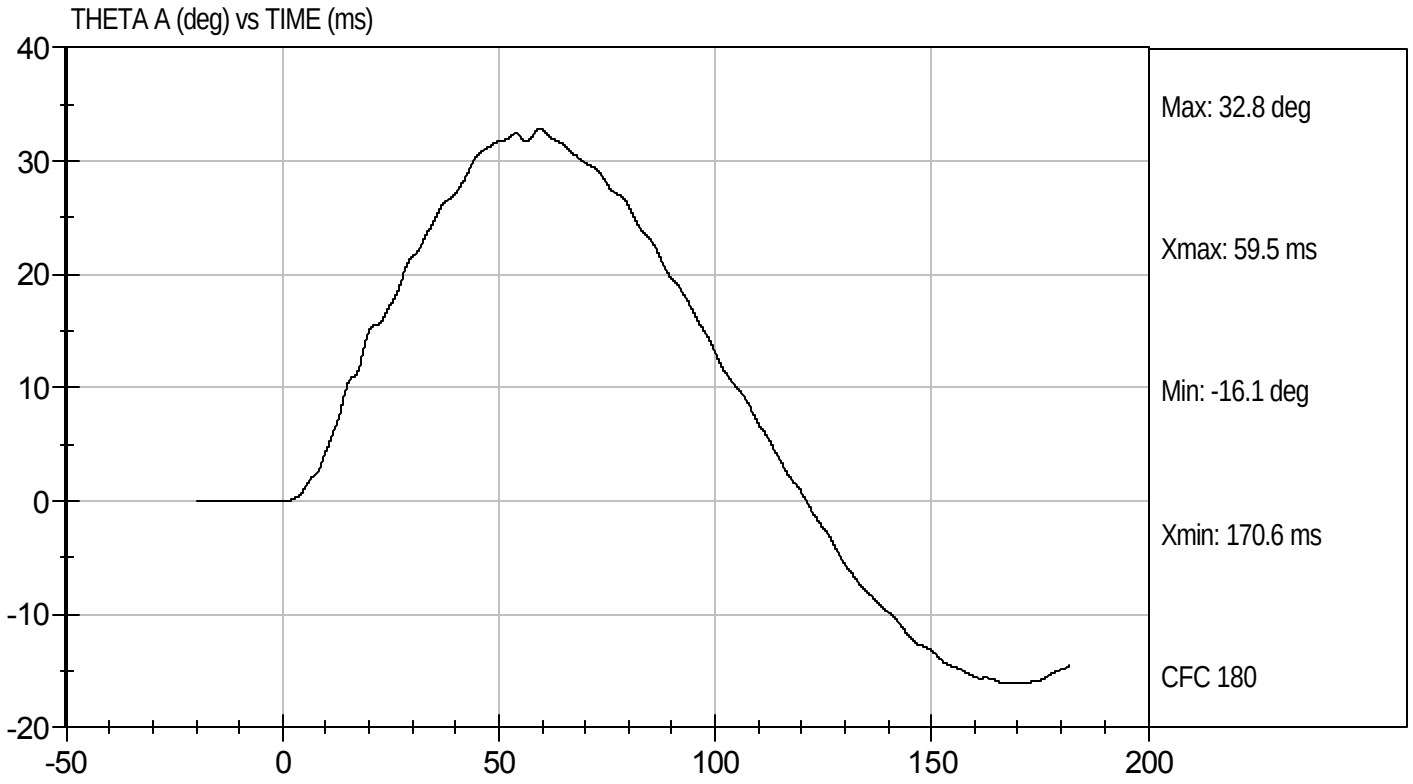


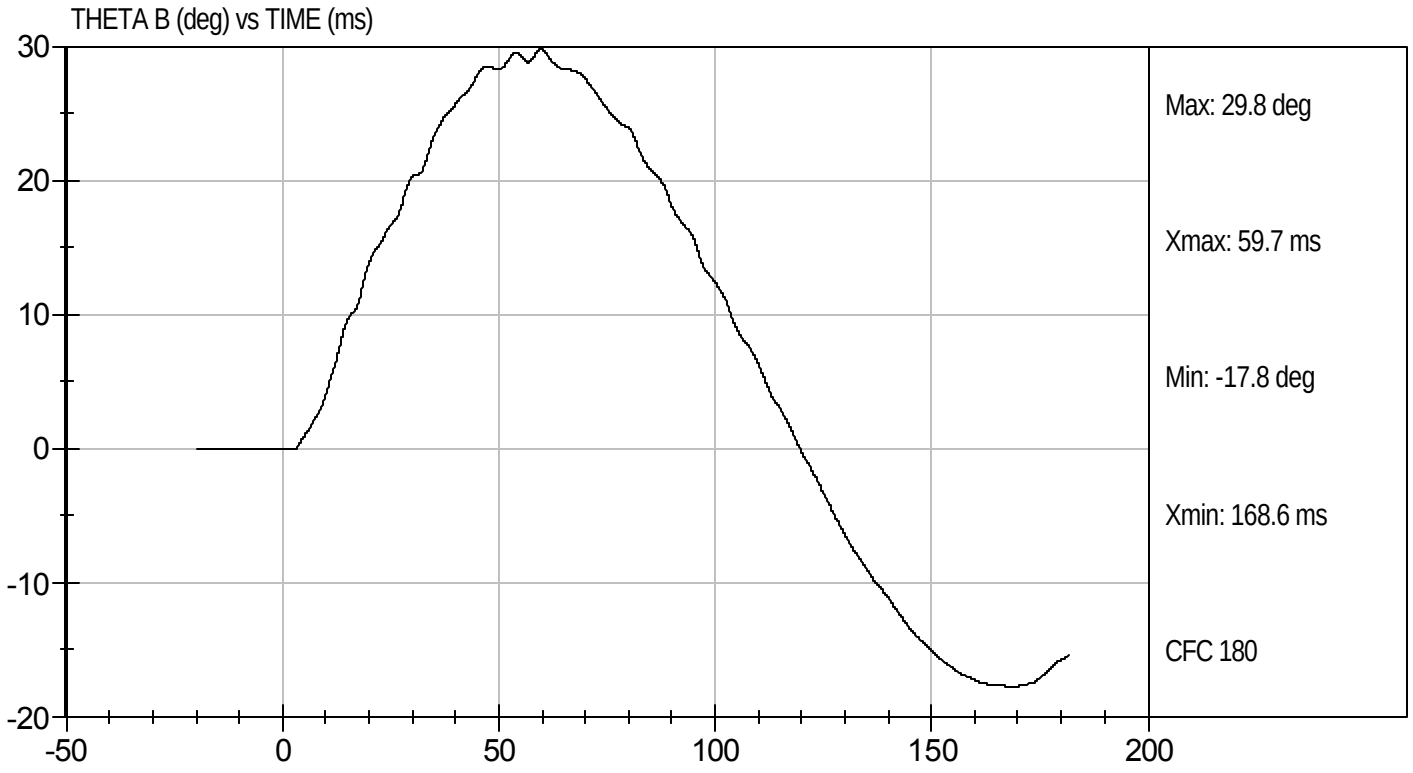
FLEXION ANGLE (deg) vs TIME (ms)



Test Desc: Neck Bending
Component ID: D111262

Test Date: 4/1/11
Velocity: 11.34 ft/s, 3.5 m/s





MGA RESEARCH CORPORATION

SHOULDER IMPACT TEST

ES-2re DUMMY

ATD Serial No: 016 **Test I.D:** D111263

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	20.6 to 22.2	21.9	Pass
Laboratory Relative Humidity	%	10 to 70	23	Pass
Pendulum Speed	m/s	4.2 to 4.4	4.3	Pass
Peak Shoulder Acceleration	G's	7.5 to 10.5	9.1	Pass
Time of Peak Shoulder Acceleration	ms	NA	13.6	Pass
		Overall Test Results		Pass

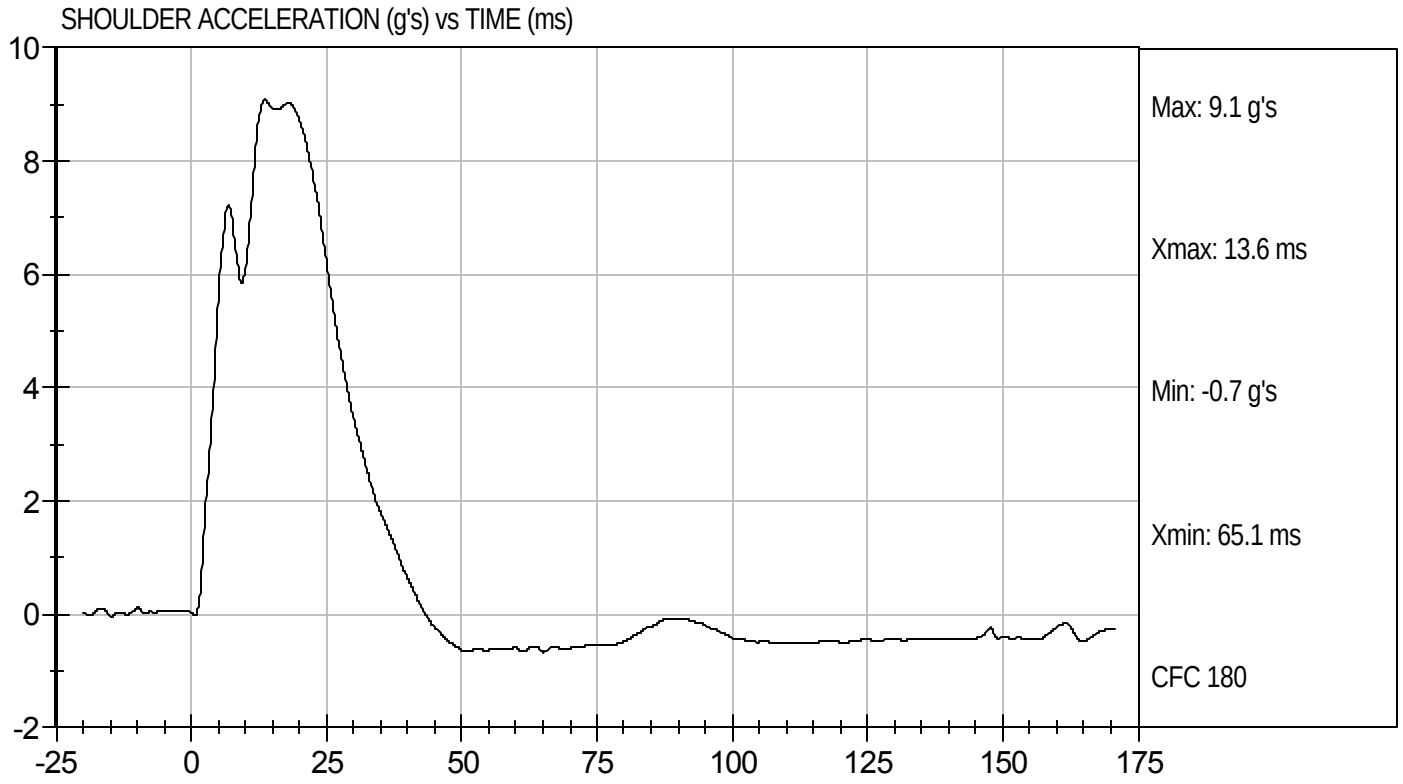
Jessica Gall
Laboratory Technician

4/1/11
Test Date

David Winkelbauer
Approved By

Test Desc: Shoulder Impact
Component ID: D111263

Test Date: 4/1/11
Velocity: 14.25 ft/s, 4.3 m/s



MGA RESEARCH CORPORATION

UPPER RIB TEST

ES-2re DUMMY

ATD Serial No: 016 **Test I.D:** D111264

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	20.6 to 22.2	22.0	Pass
Laboratory Relative Humidity	%	10 to 70	26	Pass
Displacement at 3 m/s	mm	36.0 to 40.0	39.5	Pass
Displacement at 4 m/s	mm	46.0 to 51.0	48.7	Pass
		Overall Test Results		Pass

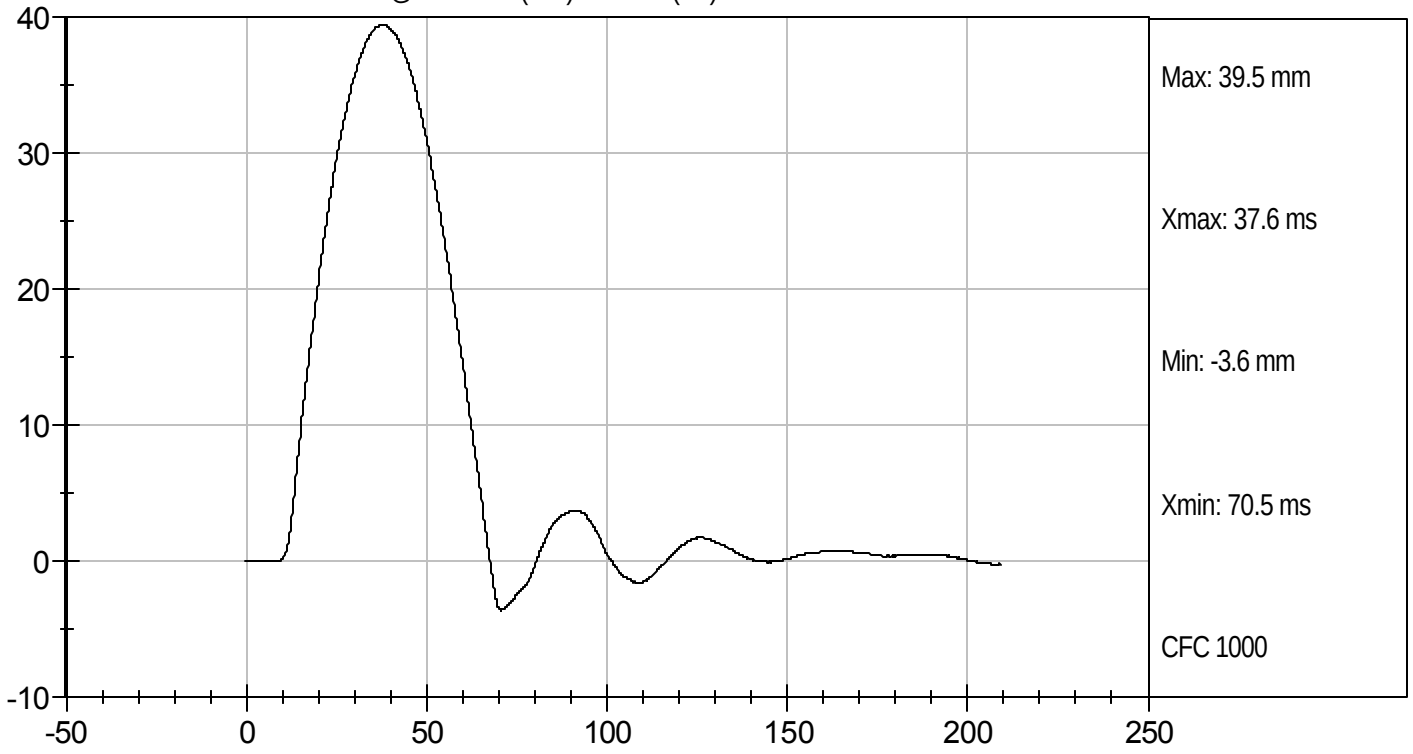
Jessica Gall
Laboratory Technician

4/1/11
Test Date

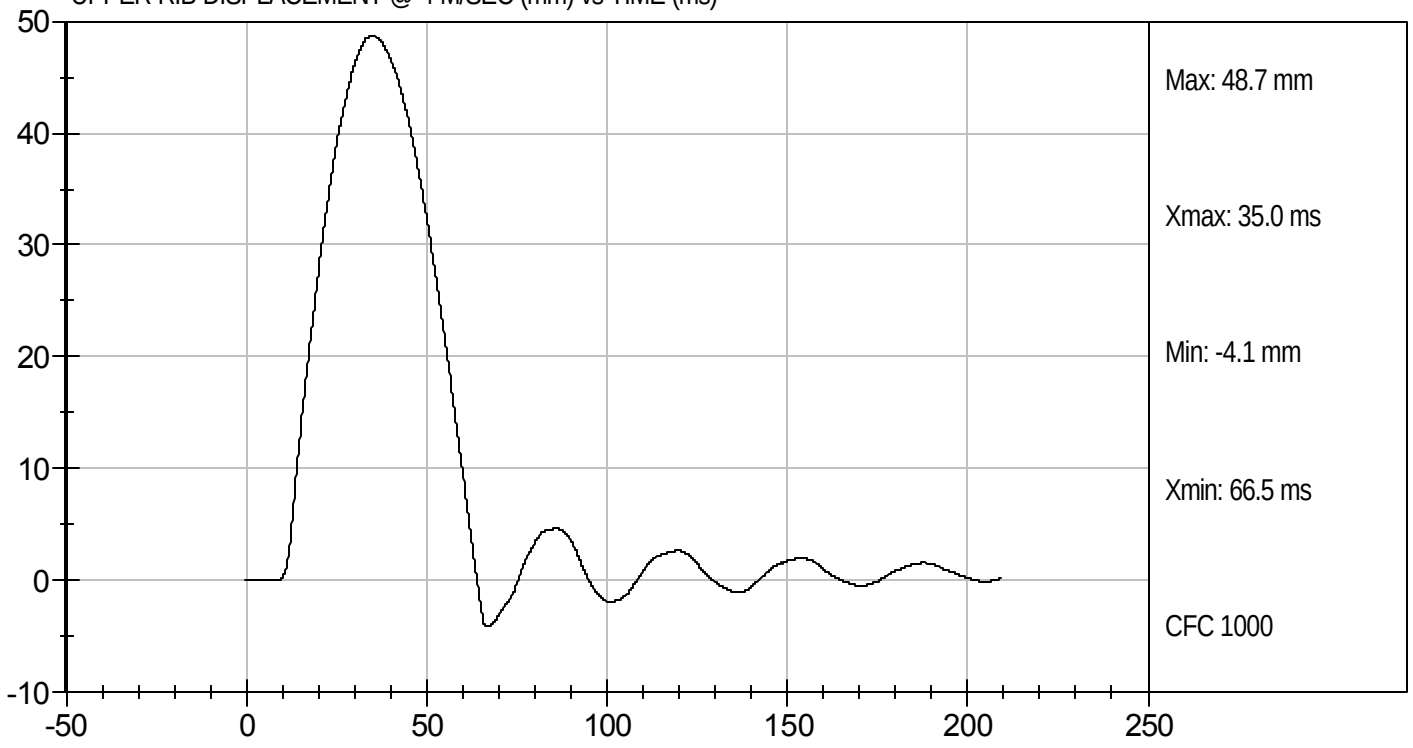
David Winkelbauer
Approved By

Test Desc: Rib Impact - Upper
Component ID: D111264
Test Date: 4/1/11

UPPER RIB DISPLACEMENT @ 3 M/SEC (mm) vs TIME (ms)



UPPER RIB DISPLACEMENT @ 4 M/SEC (mm) vs TIME (ms)



MGA RESEARCH CORPORATION

MID RIB TEST

ES-2re DUMMY

ATD Serial No: 016 **Test I.D:** D111265

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	20.6 to 22.2	22.0	Pass
Laboratory Relative Humidity	%	10 to 70	26	Pass
Displacement at 3 m/s	mm	36.0 to 40.0	38.1	Pass
Displacement at 4 m/s	mm	46.0 to 51.0	49.2	Pass
		Overall Test Results		Pass

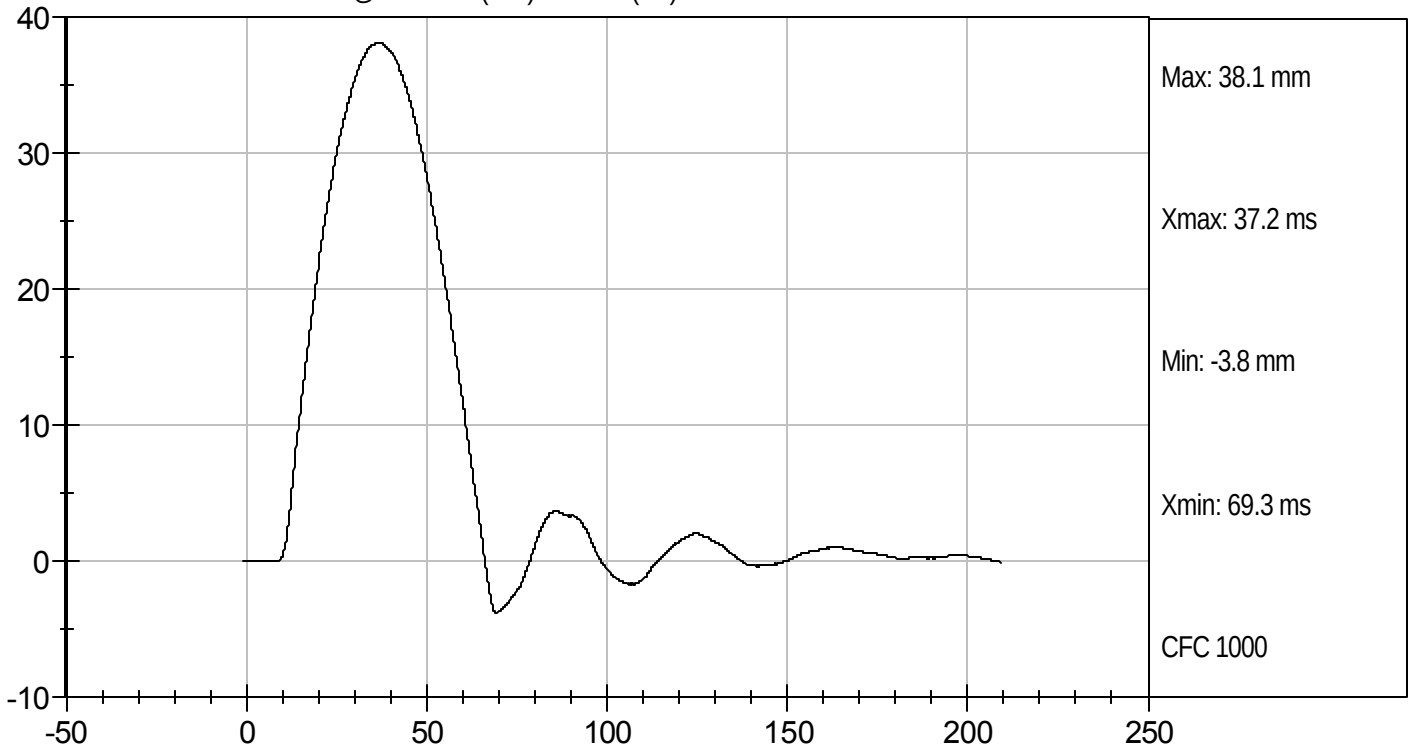
Jessica Gall
Laboratory Technician

4/1/11
Test Date

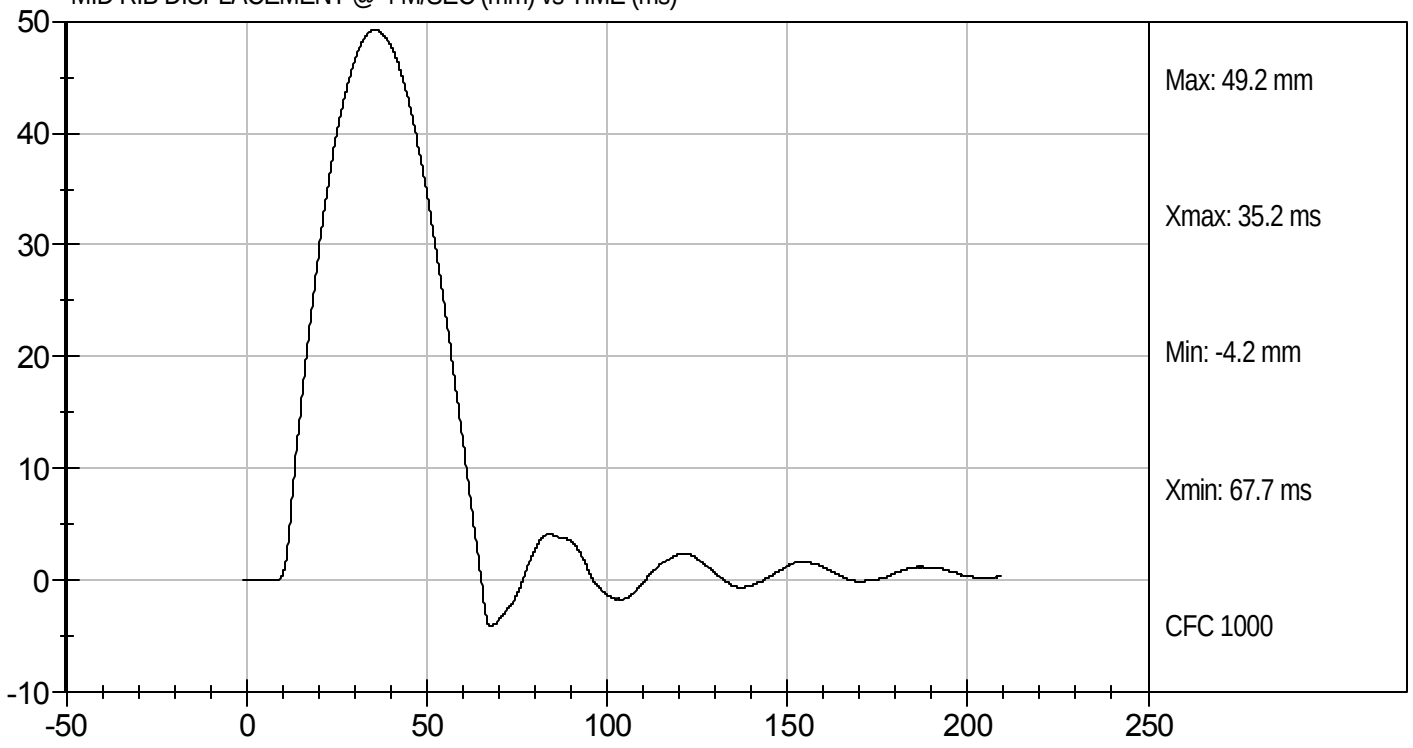
David Winkelbauer
Approved By

Test Desc: Rib Impact - Mid
Component ID: D111265
Test Date: 4/1/11

MID RIB DISPLACEMENT @ 3 M/SEC (mm) vs TIME (ms)



MID RIB DISPLACEMENT @ 4 M/SEC (mm) vs TIME (ms)



MGA RESEARCH CORPORATION

LOWER RIB TEST

ES-2re DUMMY

ATD Serial No: 016 **Test I.D:** D111266

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	20.6 to 22.2	22.0	Pass
Laboratory Relative Humidity	%	10 to 70	26	Pass
Displacement at 3 m/s	mm	36.0 to 40.0	38.0	Pass
Displacement at 4 m/s	mm	46.0 to 51.0	49.0	Pass
		Overall Test Results		Pass

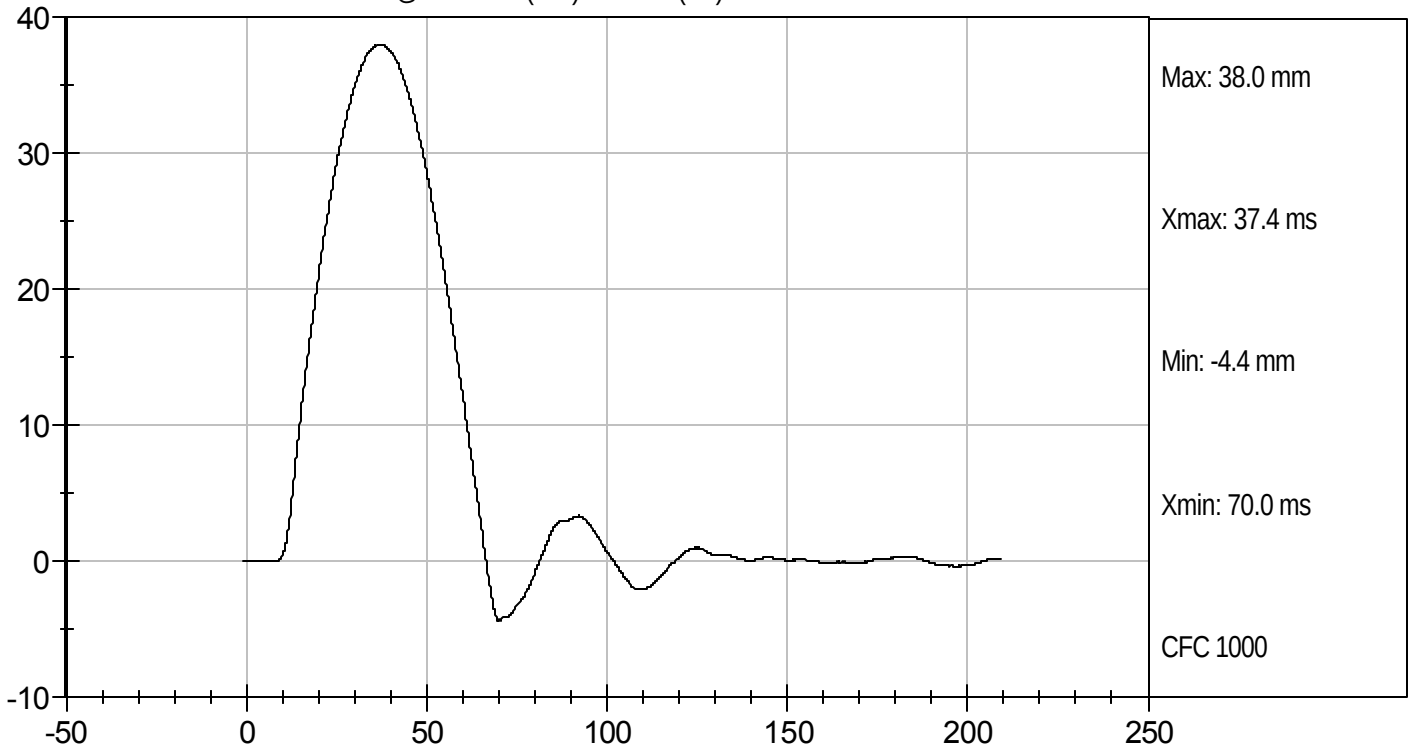
Jessica Gall
Laboratory Technician

4/1/11
Test Date

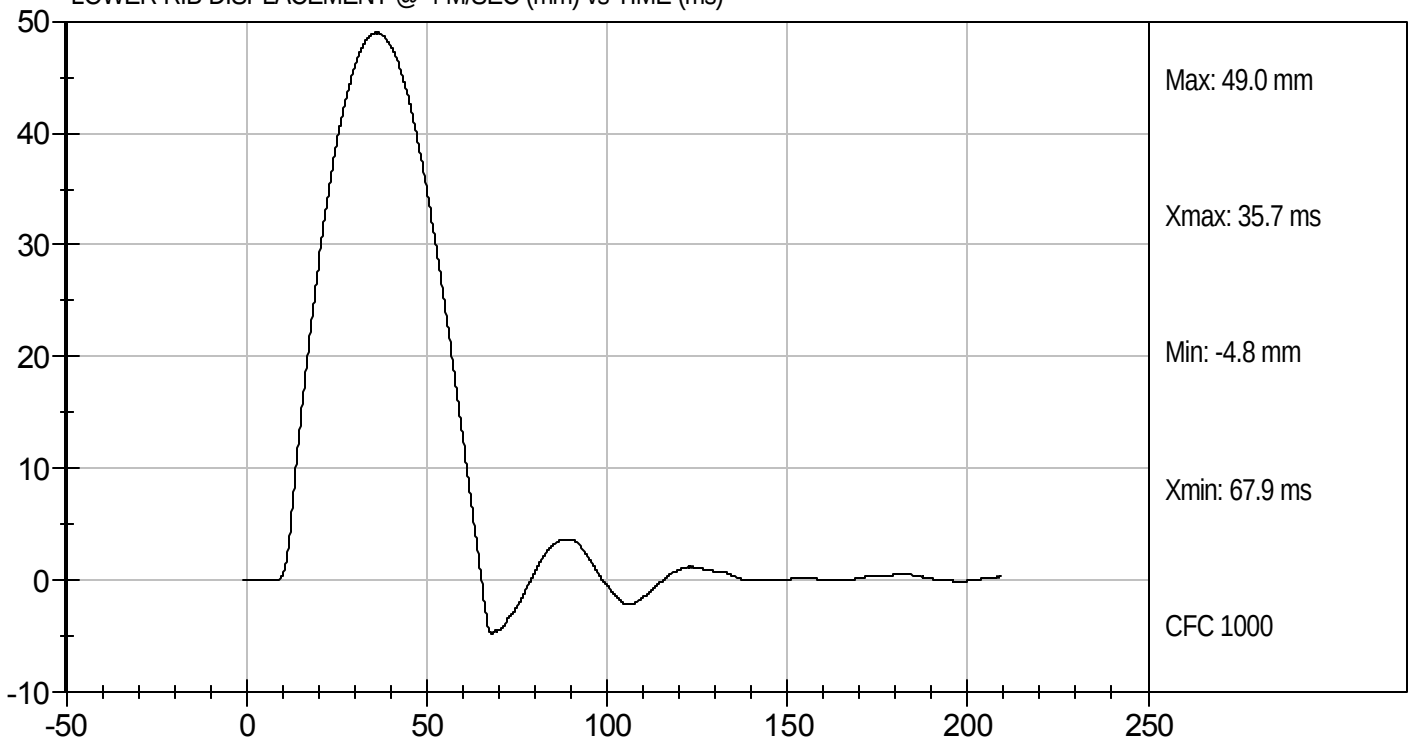
David Winkelbauer
Approved By

Test Desc: Rib Impact - Lower
Component ID: D111266
Test Date: 4/1/11

LOWER RIB DISPLACEMENT @ 3 M/SEC (mm) vs TIME (ms)



LOWER RIB DISPLACEMENT @ 4 M/SEC (mm) vs TIME (ms)



MGA RESEARCH CORPORATION

ABDOMEN TEST

ES-2re DUMMY

ATD Serial No: 016 **Test I.D:** D111267

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	20.6 to 22.2	22.0	Pass
Laboratory Relative Humidity	%	10 to 70	23	Pass
Probe Speed	m/s	3.90 to 4.10	4.06	Pass
Maximum Impact Force	kN	4.00 to 4.80	4.38	Pass
Time of Maximum Impactor Force	ms	10.60 to 13.00	10.90	Pass
Maximum Total Abdomen Force	kN	2.20 to 2.70	2.64	Pass
Time of Maximum Abdomen Force	ms	10.00 to 12.30	10.10	Pass
		Overall Test Results		Pass

Jessica Hall
Laboratory Technician

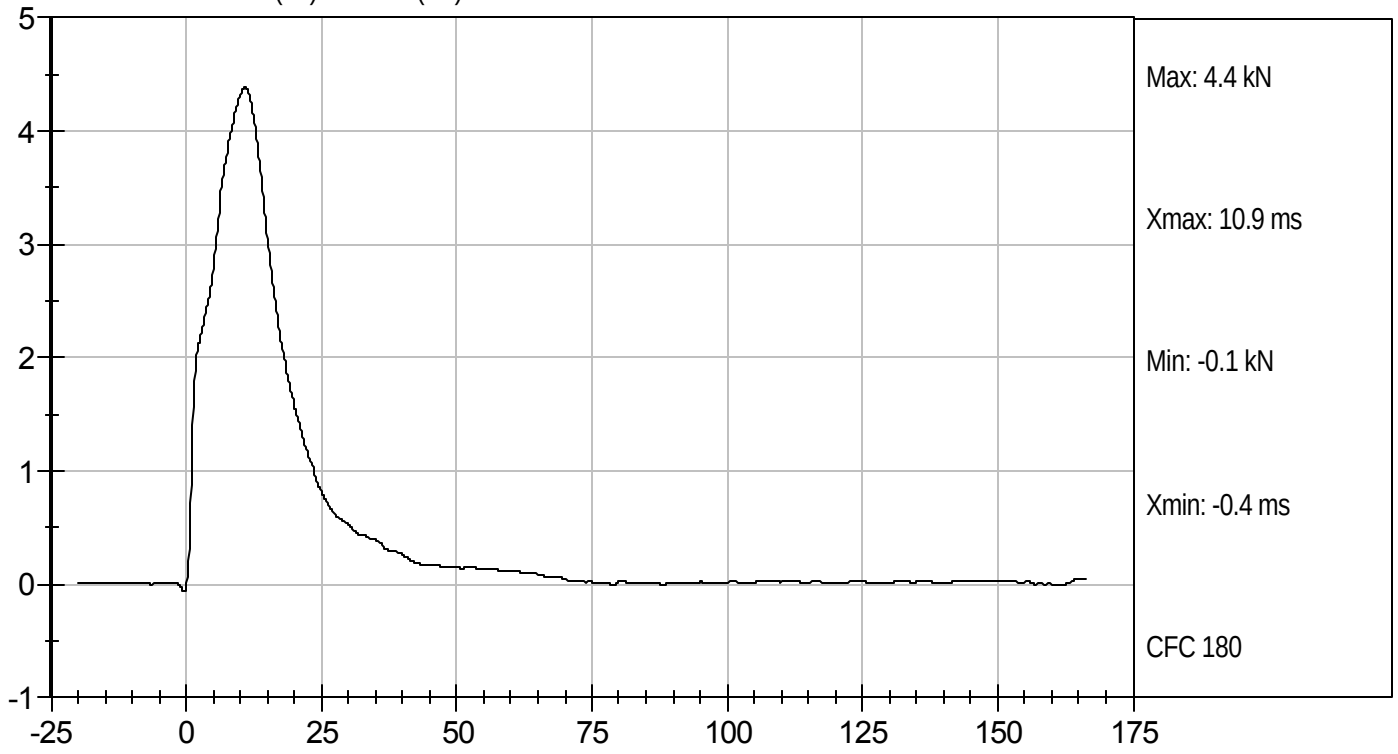
4/1/11
Test Date

David Winkelbauer
Approved By

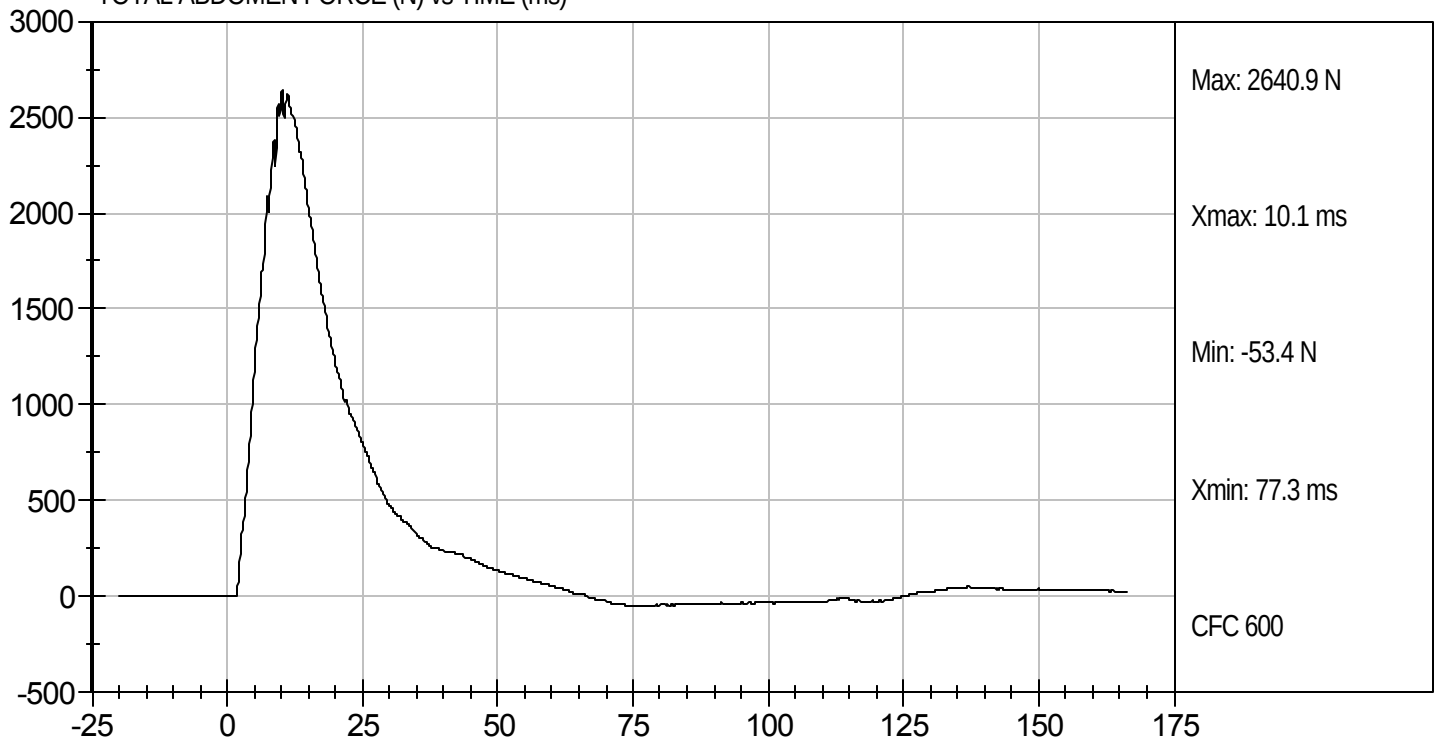
Test Desc: Abdomen Impact
Component ID: D111267

Test Date: 4/1/11
Velocity: 13.33 ft/s, 4.06 m/s

IMPACTOR FORCE (kN) vs TIME (ms)



TOTAL ABDOMEN FORCE (N) vs TIME (ms)



MGA RESEARCH CORPORATION

LUMBAR SPINE TEST

ES-2re DUMMY

ATD Serial No: 016 **Test I.D:** D111268

Tested Parameter		Units	Specification	Result	Pass/Fail
Laboratory Temperature		deg C	20.6 to 22.2	22.0	Pass
Laboratory Relative Humidity		%	10 to 70	26	Pass
Pendulum Speed		m/s	5.95 to 6.15	6.12	Pass
Pendulum Deceleration	1 ms	m/s	-0.05 to 0.00	-0.02	Pass
	3.7 ms	m/s	-0.425 to -0.24	-0.41	Pass
	27 ms	m/s	-6.50 to -5.80	-5.81	Pass
	30 ms	m/s	>= -6.5	-6.14	Pass
Maximum Flexion Angle		deg	45.0 to 55.0	45.9	Pass
Time of Maximum Flexion Angle		ms	39.0 to 53.0	46.2	Pass
Headform Rotation Decay to Initial Position		ms	37 to 57	45	Pass
			Overall Results		Pass

Jessica Hall
Laboratory Technician

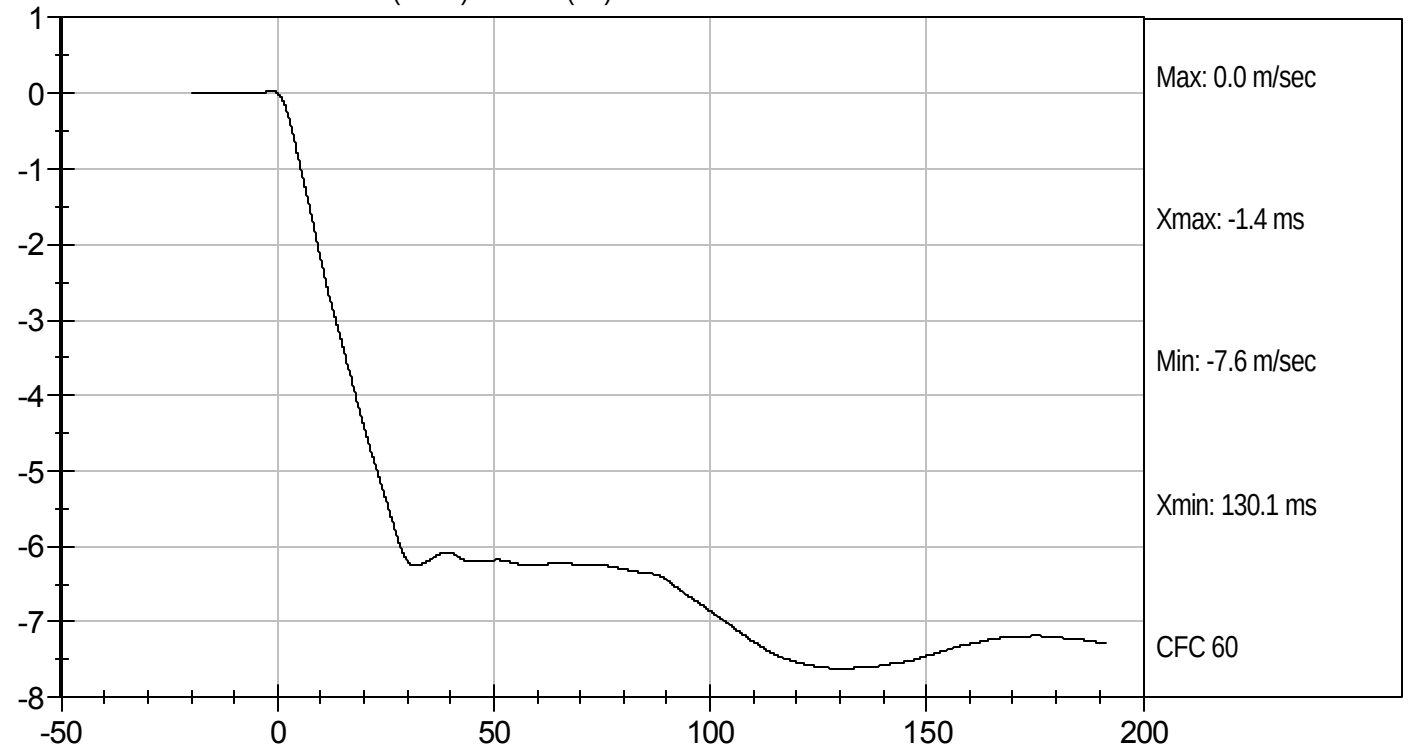
4/1/11
Test Date

David Winkelbauer
Approved By

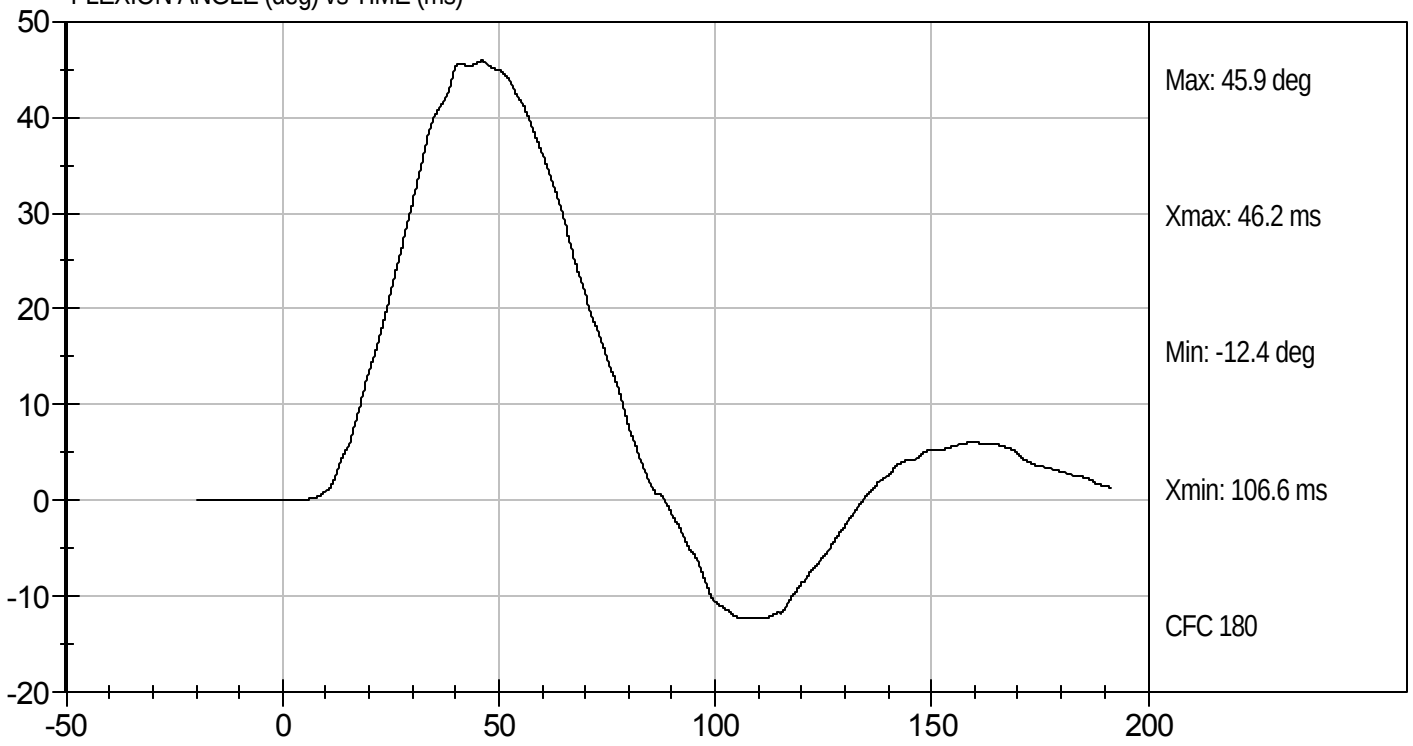
Test Desc: Lumbar Bending
Component ID: D111268

Test Date: 4/1/11
Velocity: 20.08 ft/s, 6.12 m/s

PENDULUM DECELERATION (m/sec) vs TIME (ms)

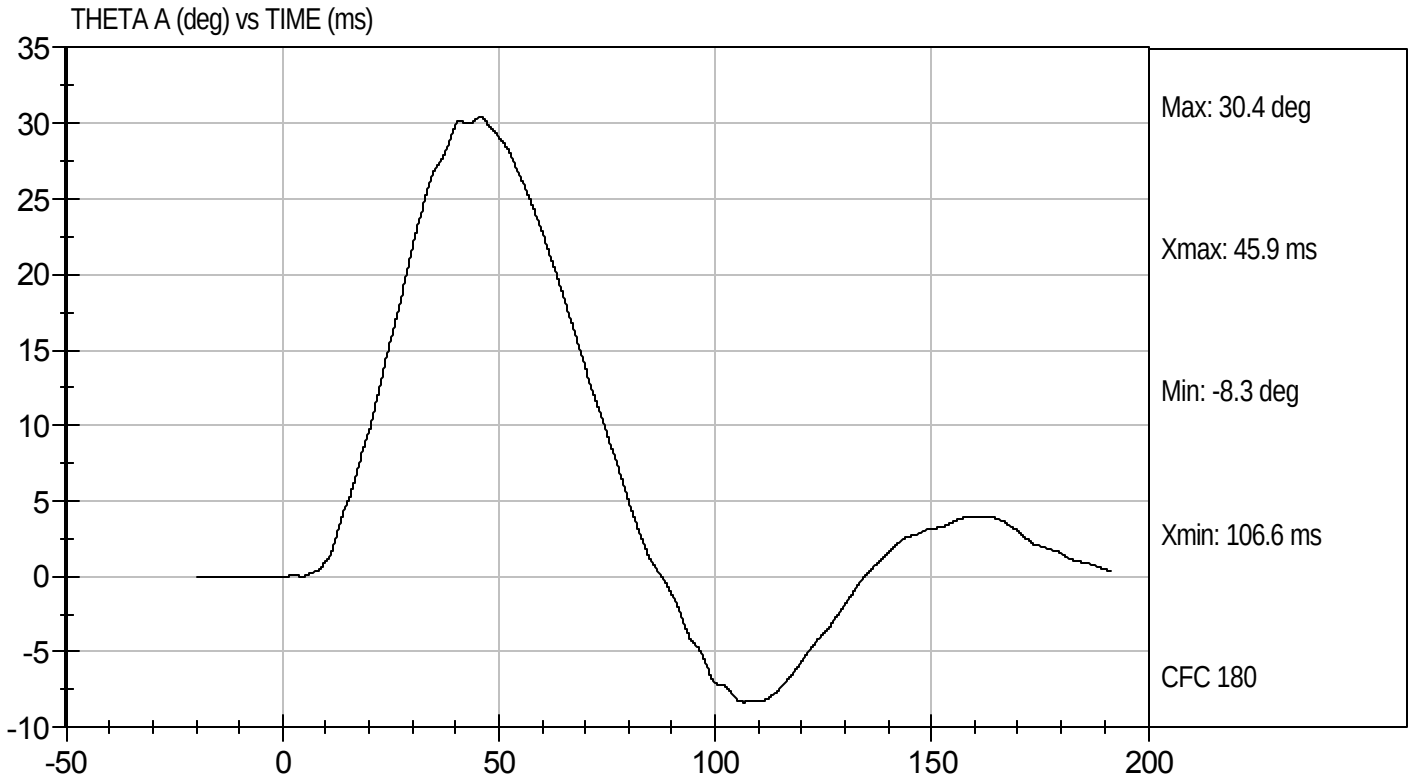


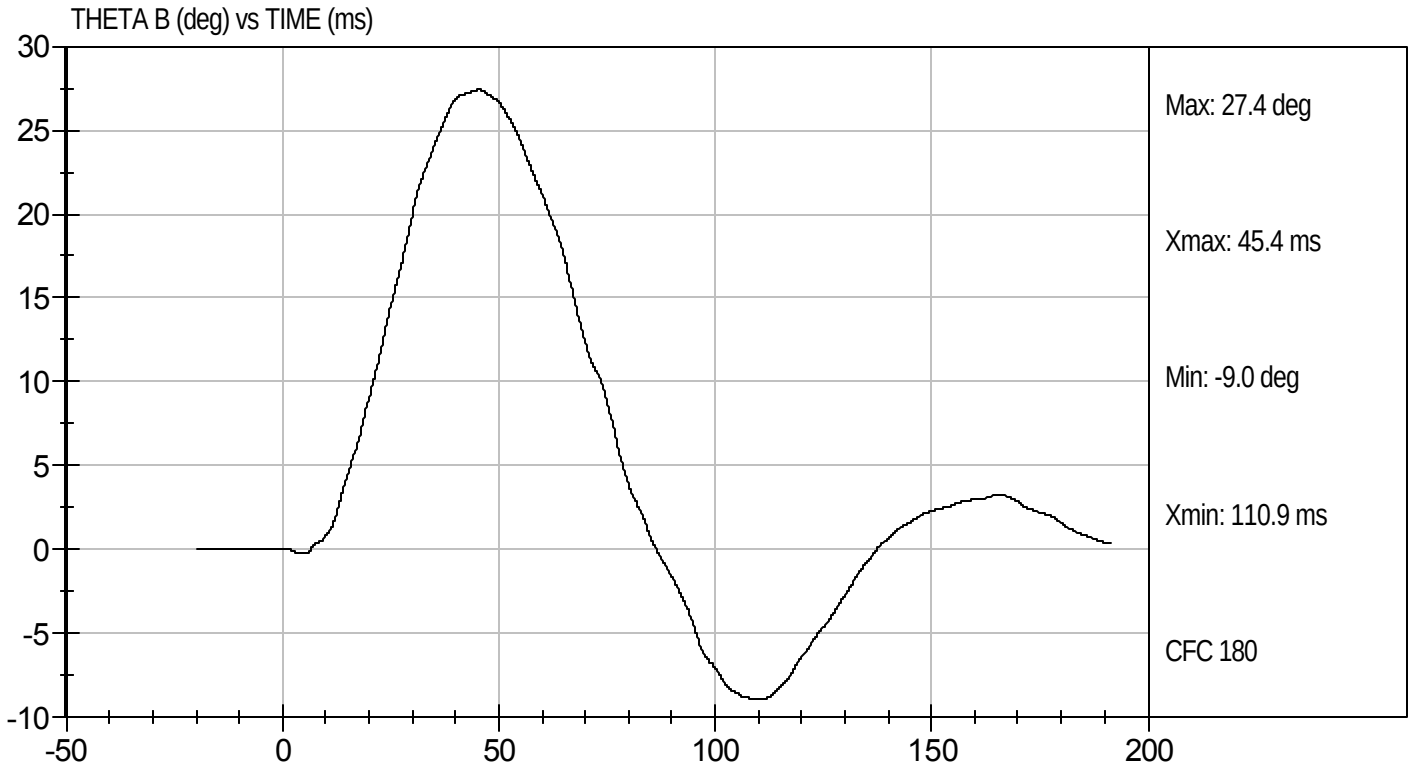
FLEXION ANGLE (deg) vs TIME (ms)



Test Desc: Lumbar Bending
Component ID: D111268

Test Date: 4/1/11
Velocity: 20.08 ft/s, 6.12 m/s





MGA RESEARCH CORPORATION

PELVIS TEST

ES-2re DUMMY

ATD Serial No: 016 **Test I.D:** D111269

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	20.6 to 22.2	21.9	Pass
Laboratory Relative Humidity	%	10 to 70	22	Pass
Probe Speed	m/s	4.20 to 4.40	4.34	Pass
Maximum Impactor Force	kN	4.70 to 5.40	4.77	Pass
Time of Maximum Impactor Force	ms	11.80 to 16.10	13.80	Pass
Maximum Pubic Force	kN	1.23 to 1.59	1.42	Pass
Time of Maximum Pubic Force	ms	12.20 to 17.00	14.70	Pass
		Overall Test Results		Pass

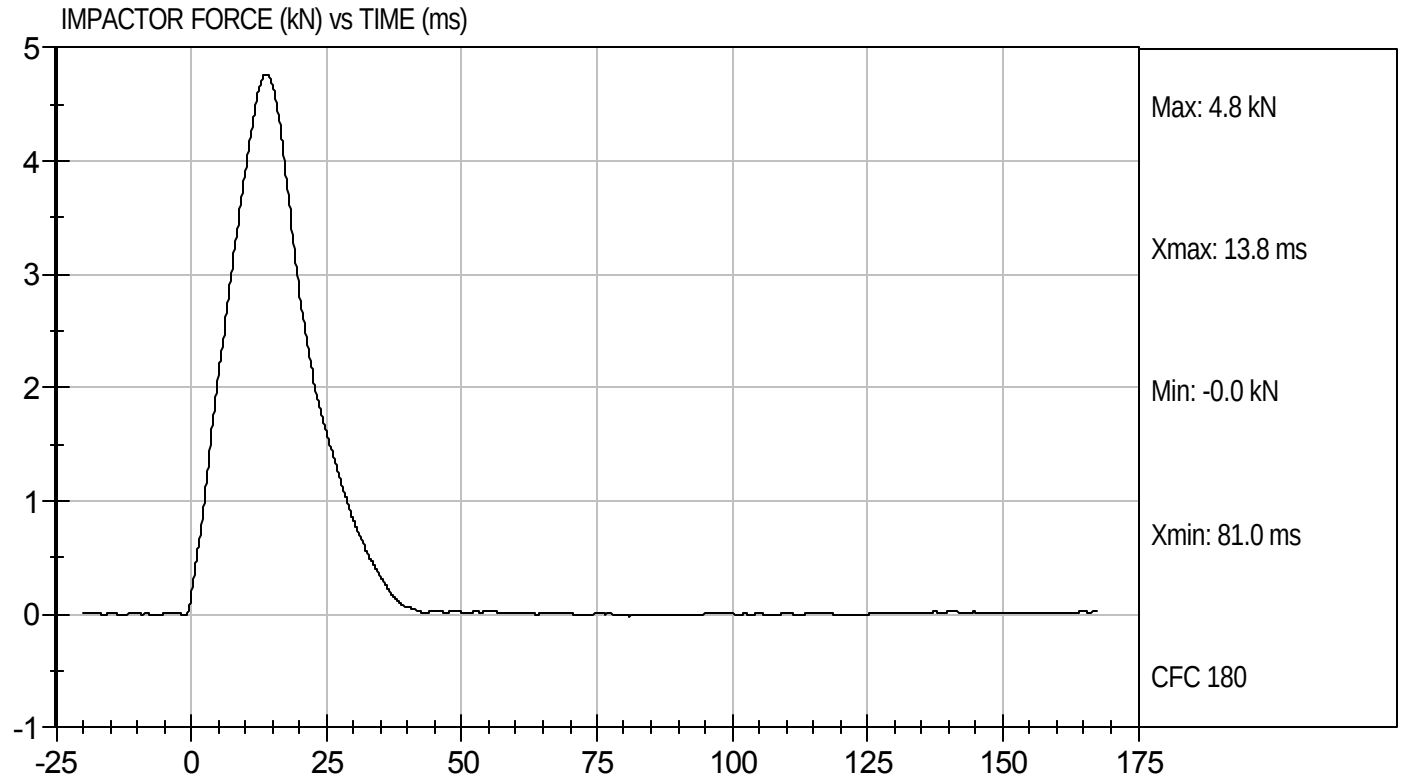
Jessica Gall
Laboratory Technician

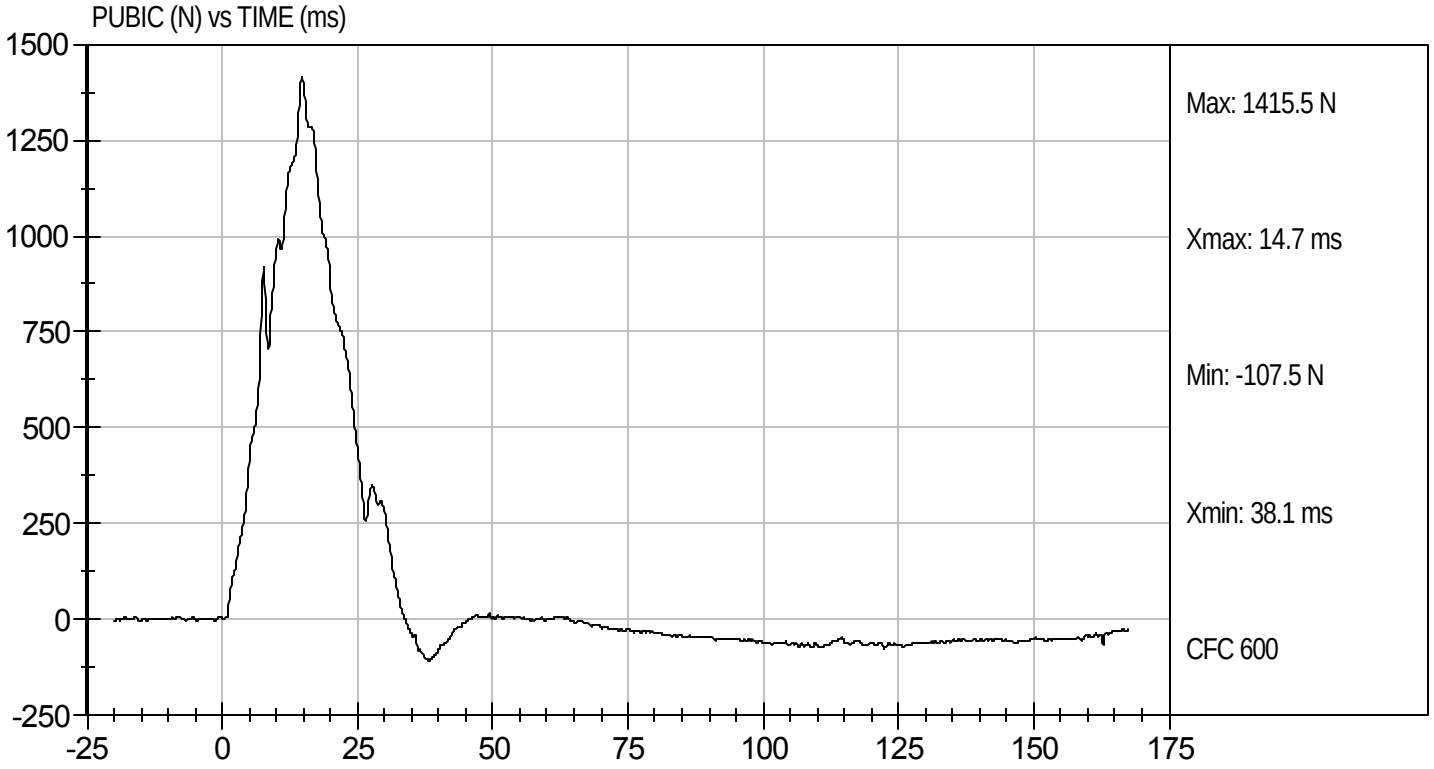
4/1/11
Test Date

David Winkelbauer
Approved By

Test Desc: Pelvis Impact
Component ID: D111269

Test Date: 4/1/11
Velocity: 14.25 ft/s, 4.34 m/s





MGA RESEARCH CORPORATION

FULL BODY THORAX IMPACT TEST

ES-2re DUMMY

ATD Serial No: 016 **Test I.D:** D111260

Tested Parameter	Units	Specification	Result	Pass/Fail
Temperature	deg C	20.6 to 22.2	22.0	Pass
Humidity	%	10 to 70	22	Pass
Probe Speed	m/s	5.40 to 5.60	5.58	Pass
Maximum Impactor Force (after 6 ms)	kN	5.10 to 6.20	5.14	Pass
Upper Rib Displacement	mm	34.0 to 41.0	39.9	Pass
Middle Rib Displacement	mm	37.0 to 45.0	41.3	Pass
Lower Rib Displacement	mm	37.0 to 44.0	39.5	Pass
		Overall Test Results		Pass

Jessica Hall
Laboratory Technician

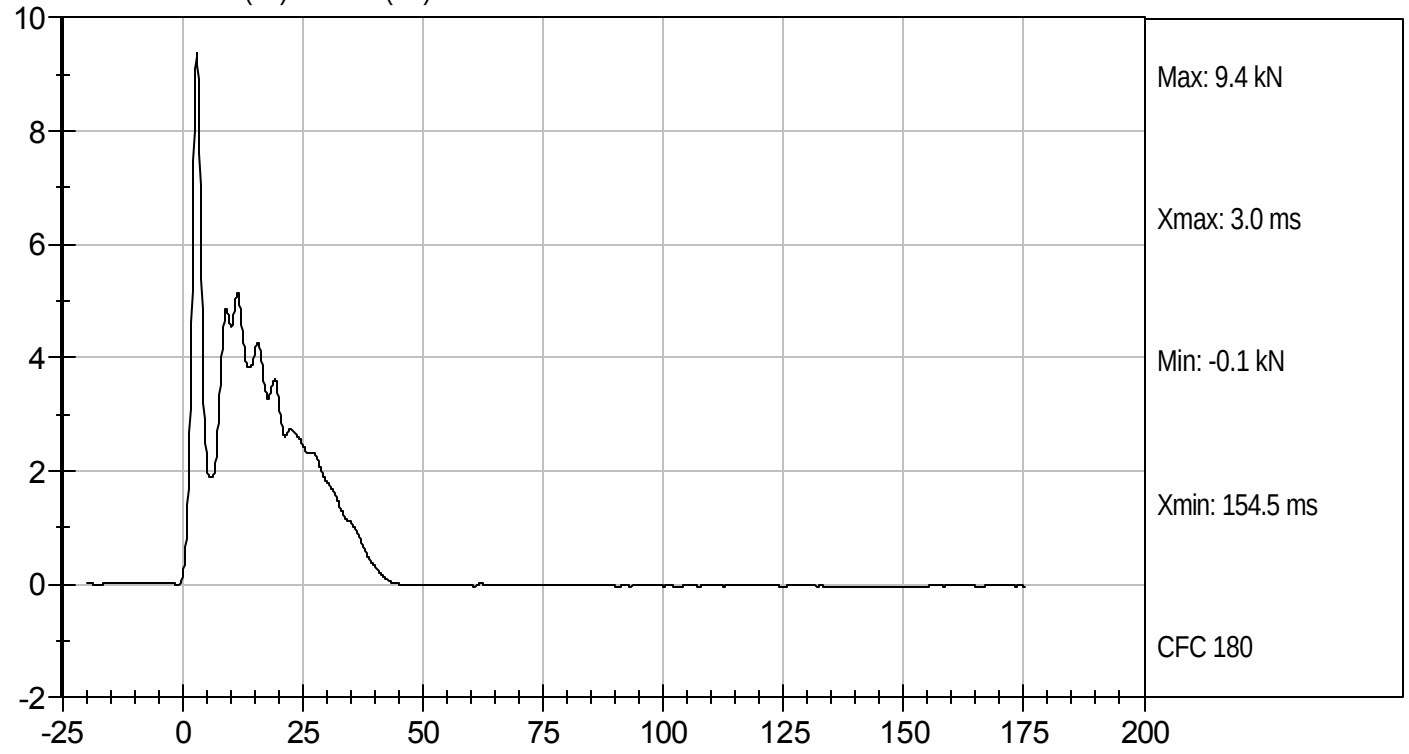
4/1/11
Test Date

David Winkelbauer
Approved By

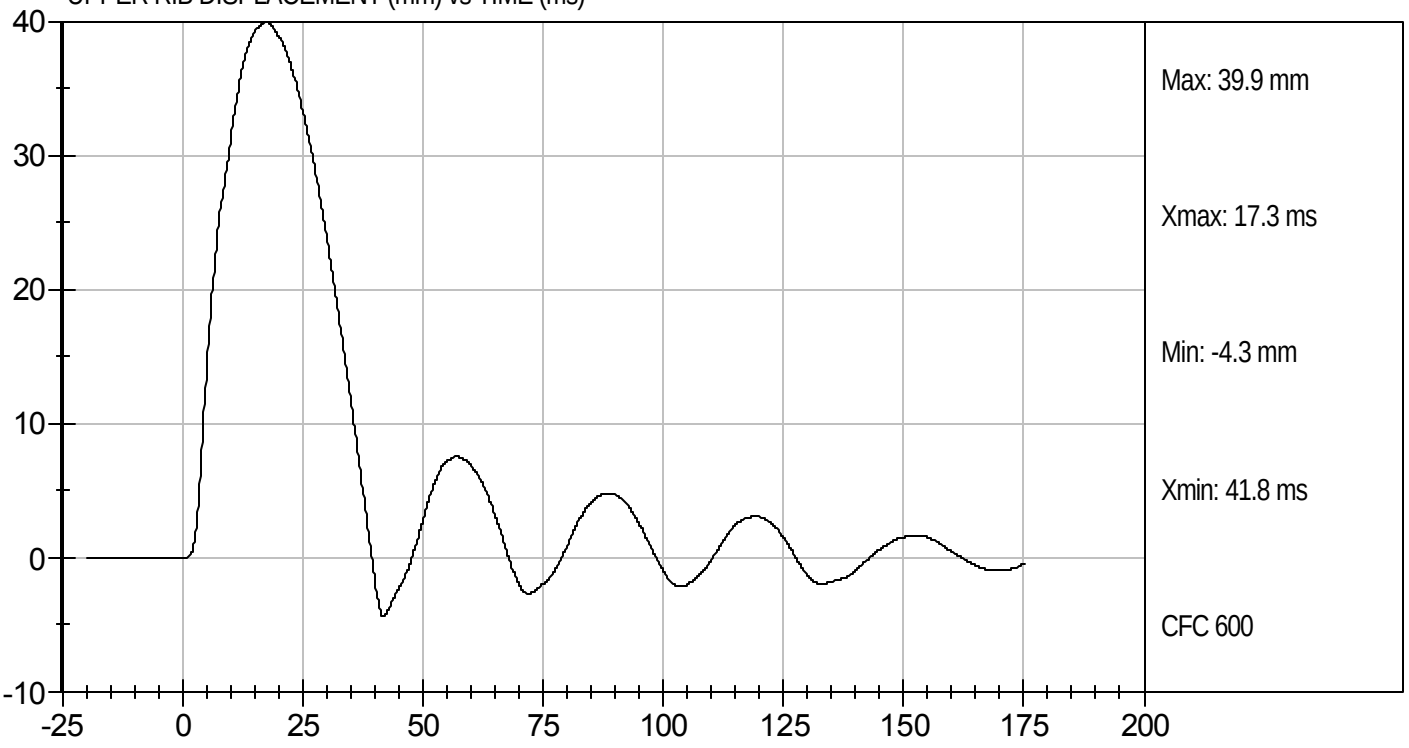
Test Desc: Thorax Impact
Component ID: D111260

Test Date: 4/1/11
Velocity: 18.32 ft/s, 5.58 m/s

PROBE FORCE (kN) vs TIME (ms)



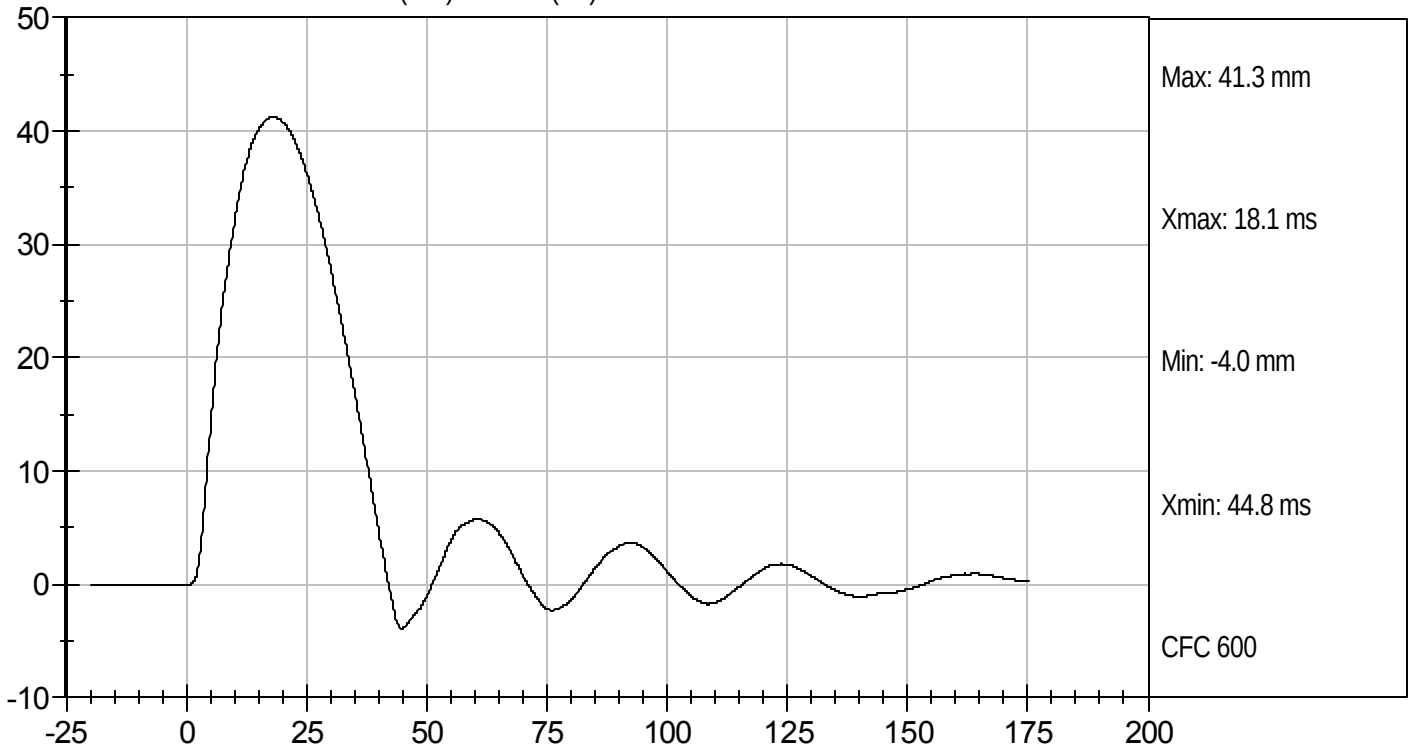
UPPER RIB DISPLACEMENT (mm) vs TIME (ms)



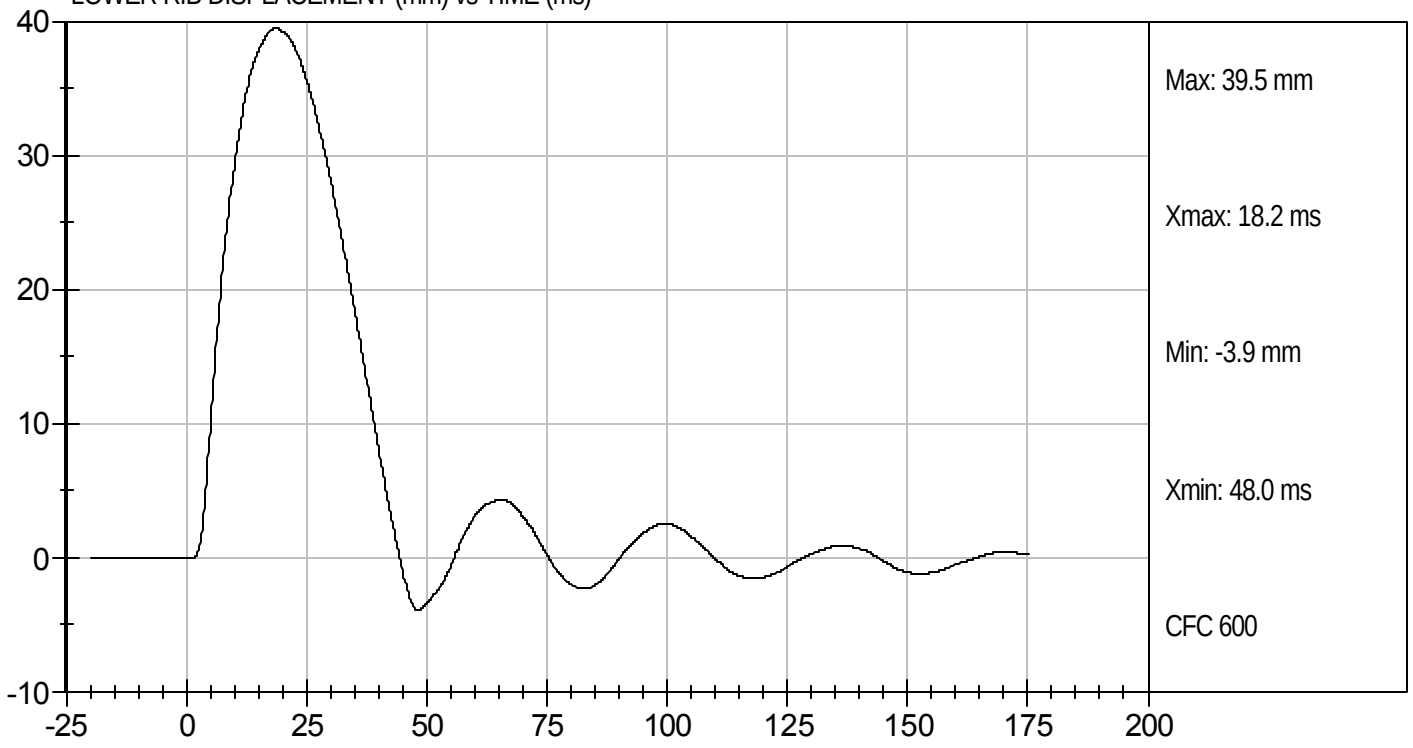
Test Desc: Thorax Impact
Component ID: D111260

Test Date: 4/1/11
Velocity: 18.32 ft/s, 5.58 m/s

MIDDLE RIB DISPLACEMENT (mm) vs TIME (ms)



LOWER RIB DISPLACEMENT (mm) vs TIME (ms)



MGA RESEARCH CORPORATION

HEAD DROP TEST

ES-2re DUMMY

ATD Serial No: 016 **Test ID:** D111271

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	22.3	Pass
Laboratory Relative Humidity	%	10 to 70	29	Pass
Peak Resultant Acceleration	G's	125 to 155	141	Pass
Peak Lateral Acceleration	G's	+/- 15	-9.7	Pass
Unimodal	N/A	Yes	Yes	Pass
Oscillations	N/A	within 15% of peak	Yes	Pass
		Overall Test Results		Pass

Jessica Hall
Laboratory Technician

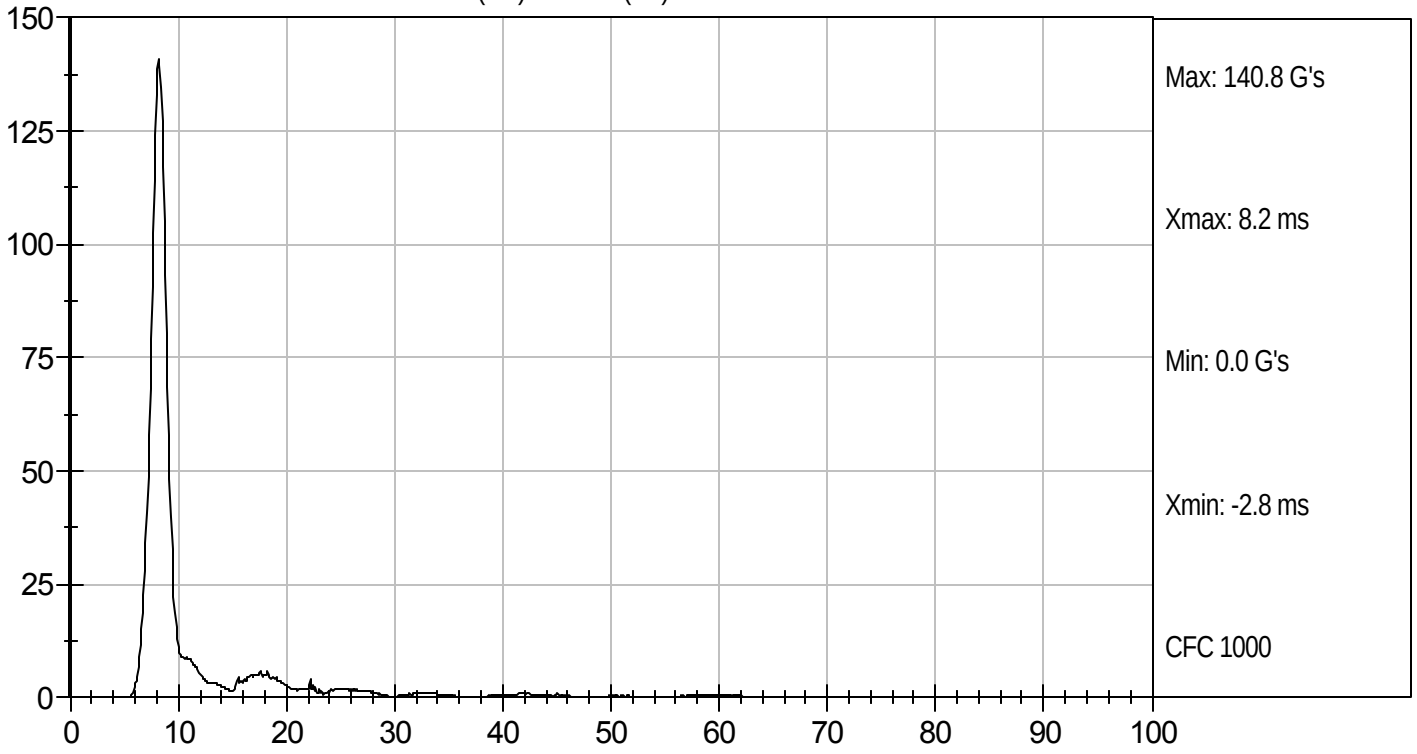
4/4/11
Test Date

David Winkelbauer
Approved By

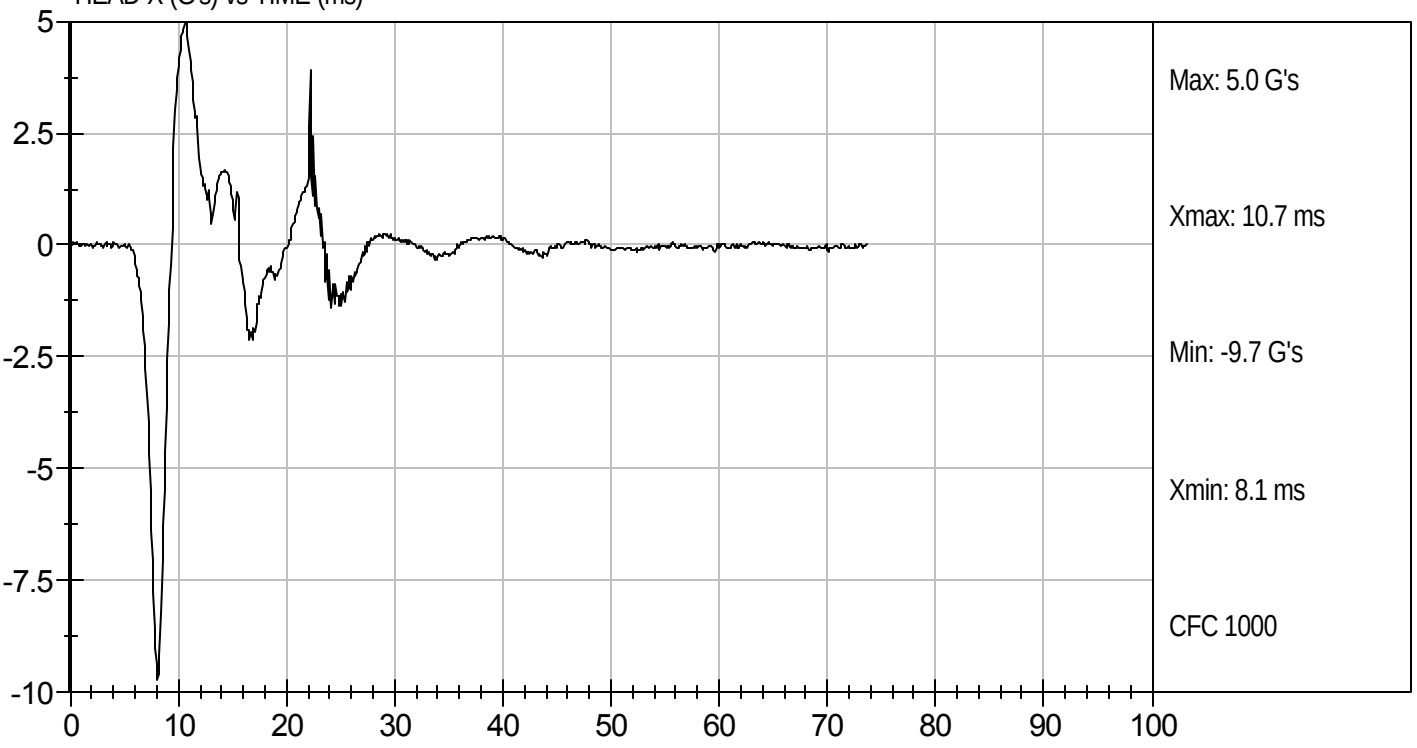
Test Desc: Head Drop
Component ID: D111271

Test Date: 4/4/11
Velocity: 0 ft/s, 0 m/s

PEAK RESULTANT ACCELERATION (G's) vs TIME (ms)



HEAD X (G's) vs TIME (ms)



MGA RESEARCH CORPORATION

NECK PENDULUM TEST

ES-2re DUMMY

ATD Serial No: 016 **Test I.D:** D111272

Tested Parameter		Units	Specification	Result	Pass/Fail
Laboratory Temperature		deg C	18.0 to 22.0	22.0	Pass
Laboratory Relative Humidity		%	10 to 70	32	Pass
Pendulum Speed		m/s	3.3 to 3.5	3.5	Pass
Pendulum Deceleration	1 ms	m/s	0.00 to -0.05	-0.02	Pass
	3 ms	m/s	-0.25 to -0.375	-0.32	Pass
	14 ms	m/s	-3.20 to -3.70	-3.32	Pass
Maximum Flexion Angle		deg	49.0 to 59.0	50.8	Pass
Time of Maximum Flexion Angle		ms	54.0 to 66.0	61.4	Pass
Head Rotation Decay Time to 0 degree		ms	53.0 to 88.0	62.0	Pass
			Overall Test Results		Pass

Jessica Hall
Laboratory Technician

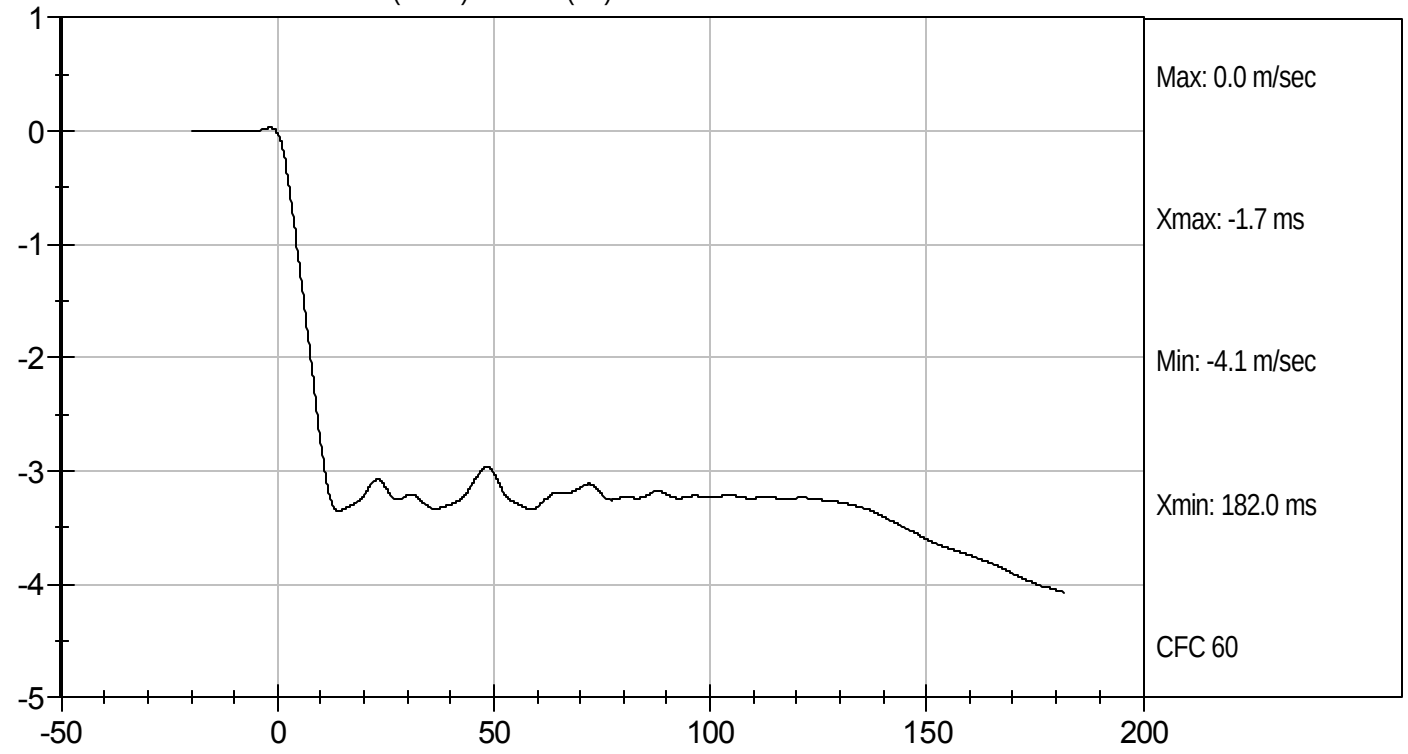
4/4/11
Test Date

David Winkelbauer
Approved By

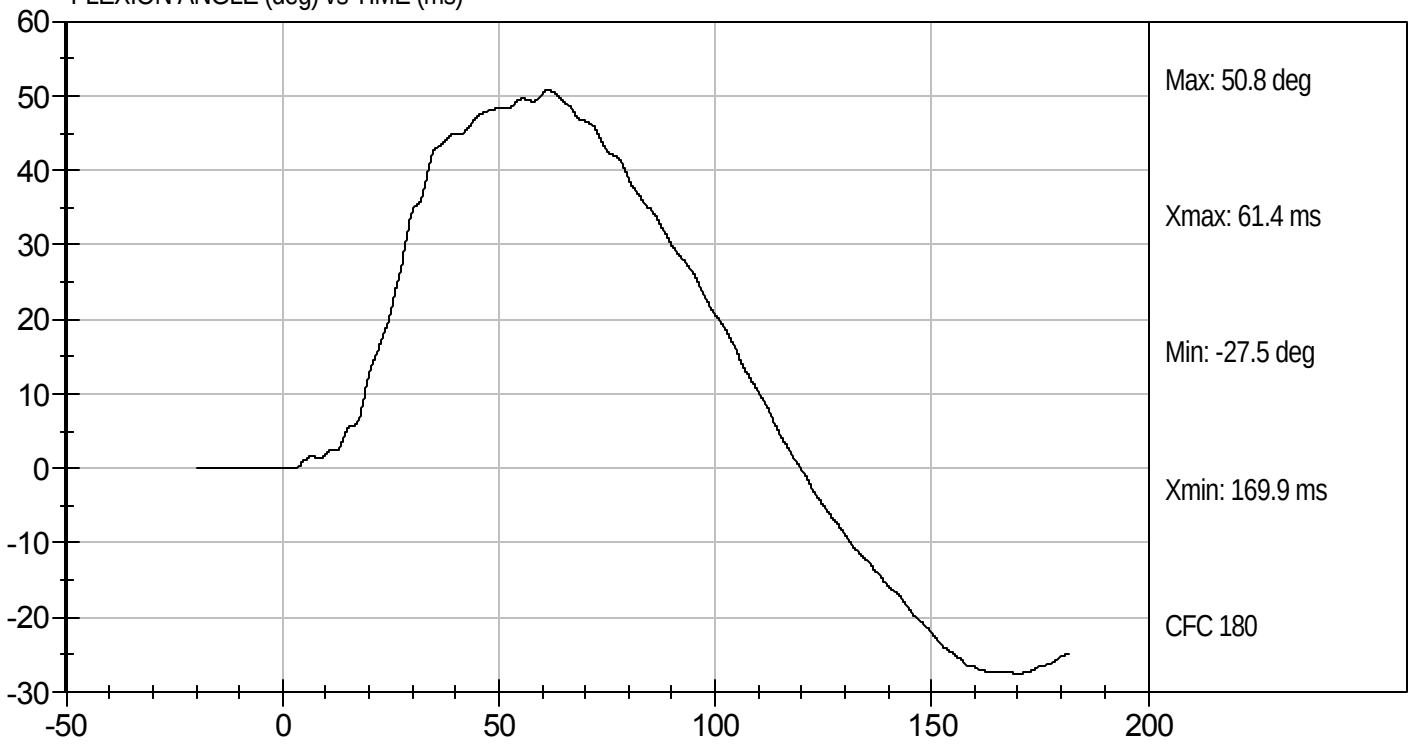
Test Desc: Neck Bending
Component ID: D111272

Test Date: 4/4/11
Velocity: 11.34 ft/s, 3.5 m/s

PENDULUM DECELERATION (m/sec) vs TIME (ms)

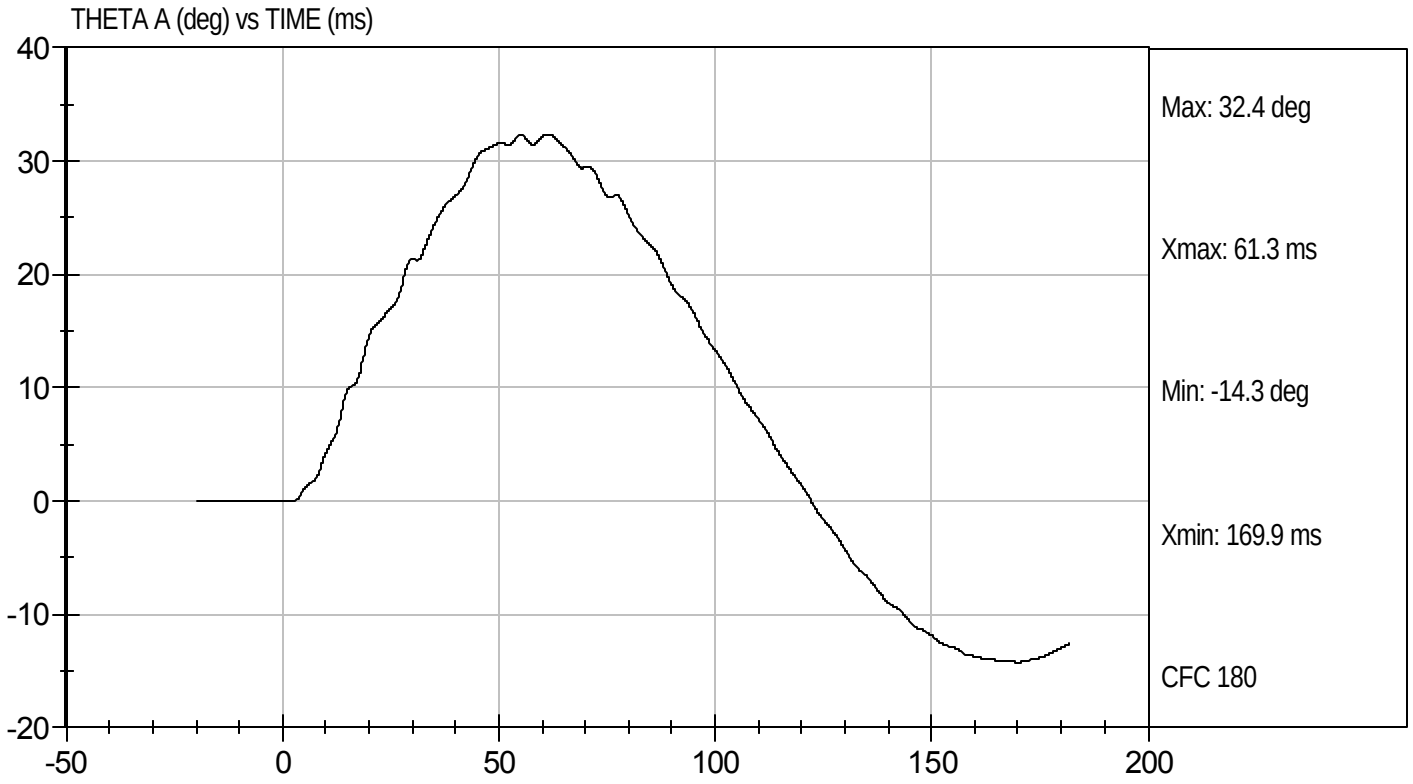


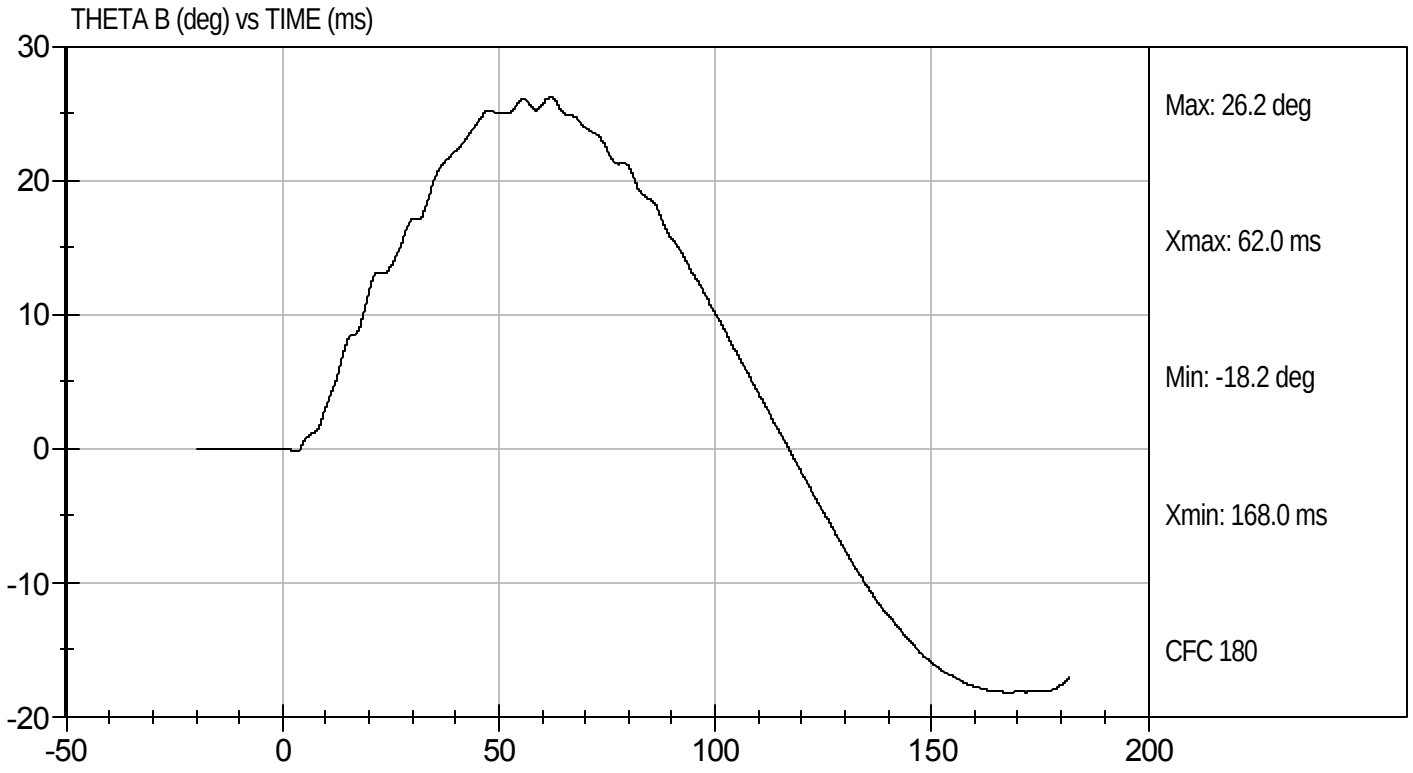
FLEXION ANGLE (deg) vs TIME (ms)



Test Desc: Neck Bending
Component ID: D111272

Test Date: 4/4/11
Velocity: 11.34 ft/s, 3..5 m/s





MGA RESEARCH CORPORATION

SHOULDER IMPACT TEST

ES-2re DUMMY

ATD Serial No: 016 **Test I.D:** D111273

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	20.6 to 22.2	21.8	Pass
Laboratory Relative Humidity	%	10 to 70	34	Pass
Pendulum Speed	m/s	4.2 to 4.4	4.3	Pass
Peak Shoulder Acceleration	G's	7.5 to 10.5	8.9	Pass
Time of Peak Shoulder Acceleration	ms	NA	18.5	Pass
		Overall Test Results		Pass

Jessica Hall
Laboratory Technician

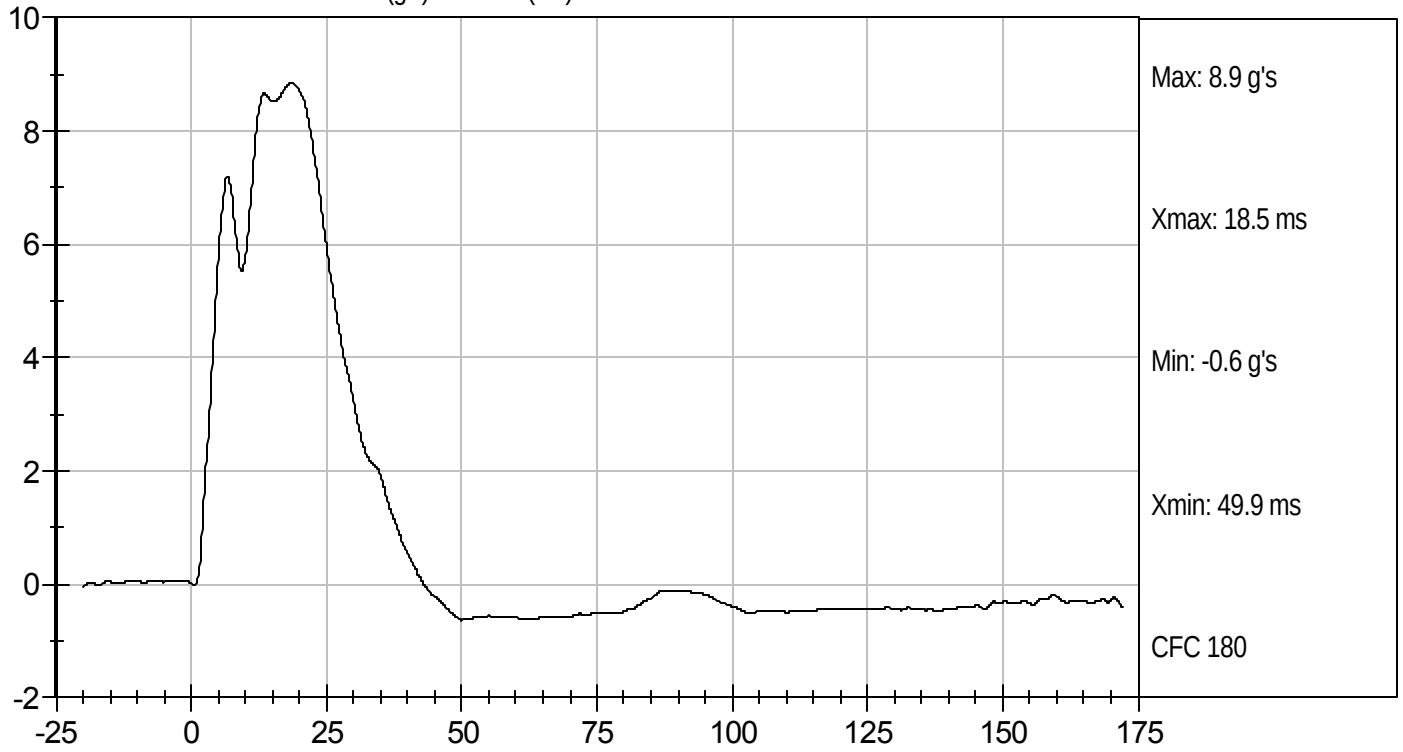
4/4/11
Test Date

David Winkelbauer
Approved By

Test Desc: Shoulder Impact
Component ID: D111273

Test Date: 4/4/11
Velocity: 14.25 ft/s, 4.3 m/s

SHOULDER ACCELERATION (g's) vs TIME (ms)



MGA RESEARCH CORPORATION

UPPER RIB TEST

ES-2re DUMMY

ATD Serial No: 016 **Test I.D:** D111274

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	20.6 to 22.2	22.1	Pass
Laboratory Relative Humidity	%	10 to 70	32	Pass
Displacement at 3 m/s	mm	36.0 to 40.0	38.9	Pass
Displacement at 4 m/s	mm	46.0 to 51.0	49.1	Pass
		Overall Test Results		Pass

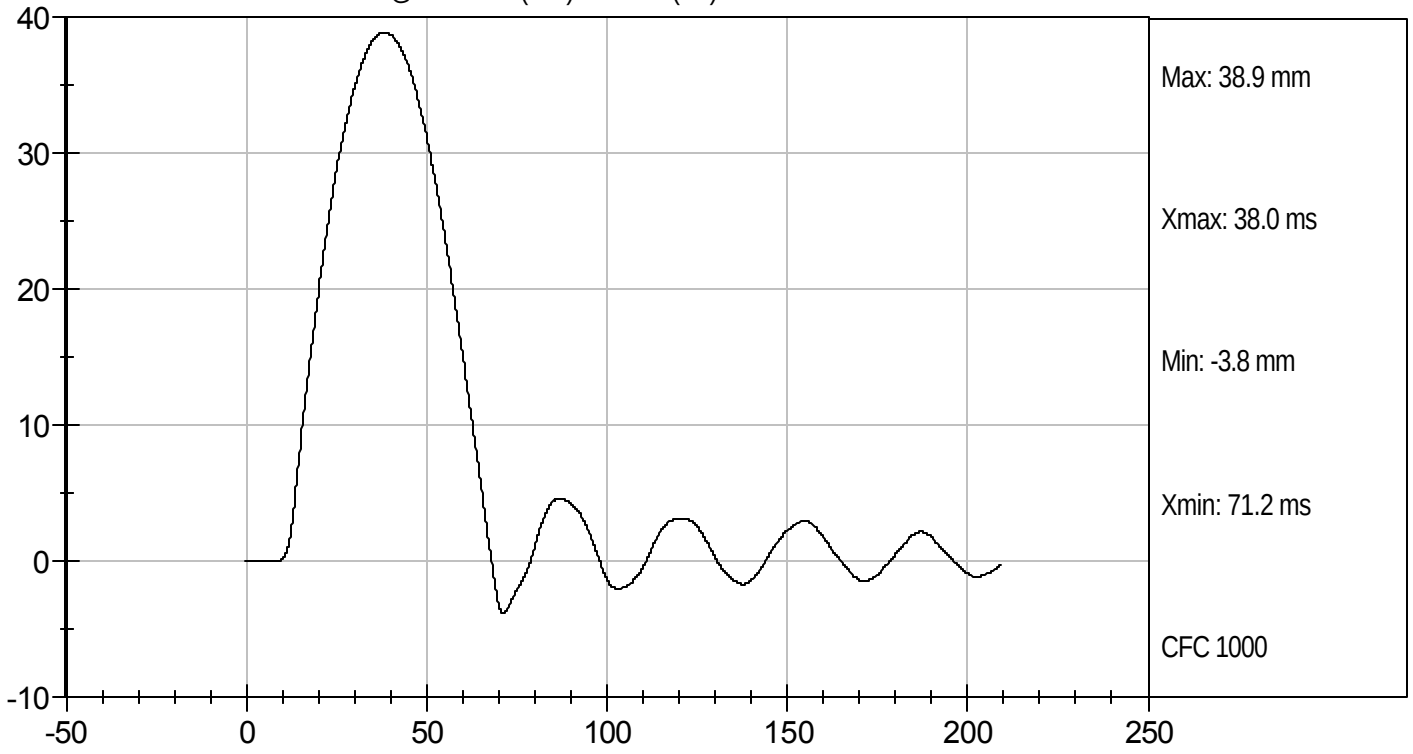
Jessica Gall
Laboratory Technician

4/4/11
Test Date

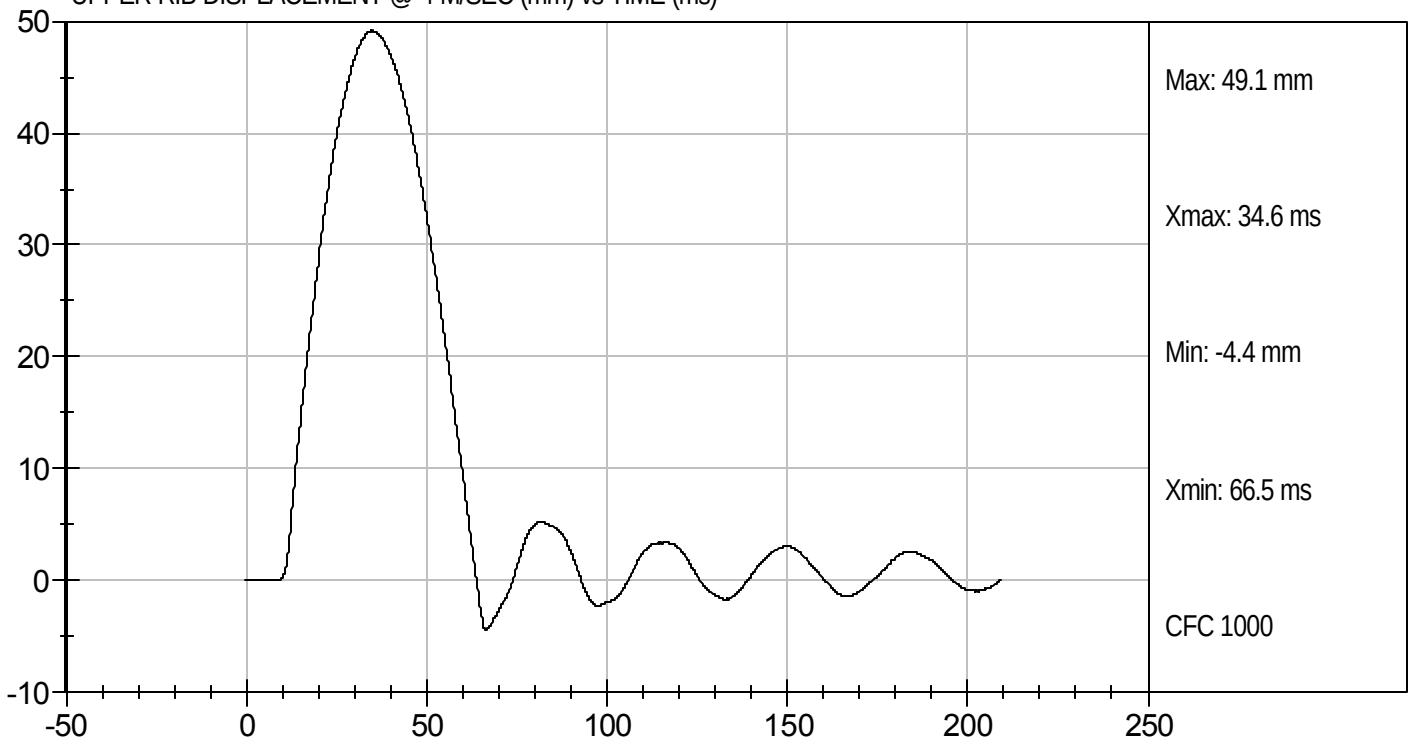
David Winkelbauer
Approved By

Test Desc: Rib Impact - Upper
Component ID: D111274
Test Date: 4/4/11

UPPER RIB DISPLACEMENT @ 3 M/SEC (mm) vs TIME (ms)



UPPER RIB DISPLACEMENT @ 4 M/SEC (mm) vs TIME (ms)



MGA RESEARCH CORPORATION

MID RIB TEST

ES-2re DUMMY

ATD Serial No: 016 **Test I.D:** D111275

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	20.6 to 22.2	22.1	Pass
Laboratory Relative Humidity	%	10 to 70	32	Pass
Displacement at 3 m/s	mm	36.0 to 40.0	38.9	Pass
Displacement at 4 m/s	mm	46.0 to 51.0	49.5	Pass
		Overall Test Results		Pass

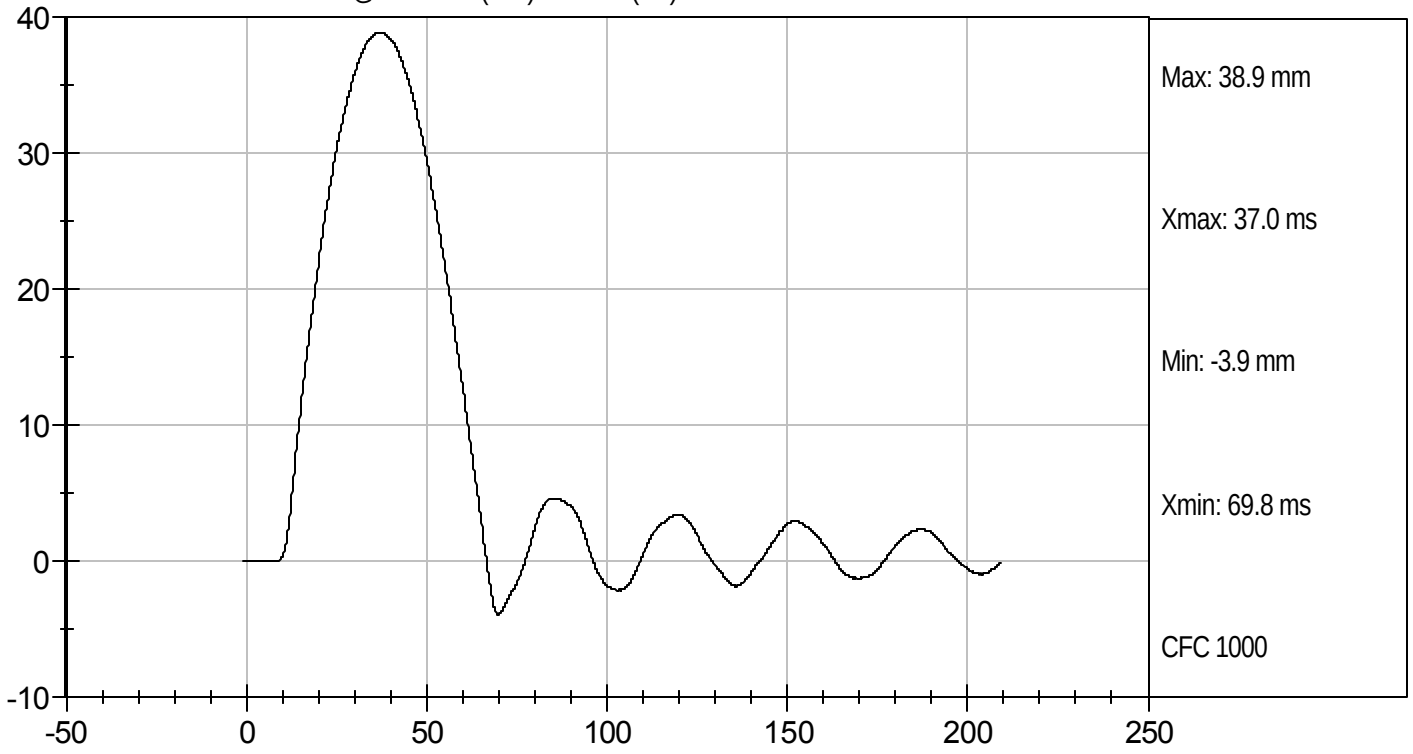
Jessica Hall
Laboratory Technician

4/4/11
Test Date

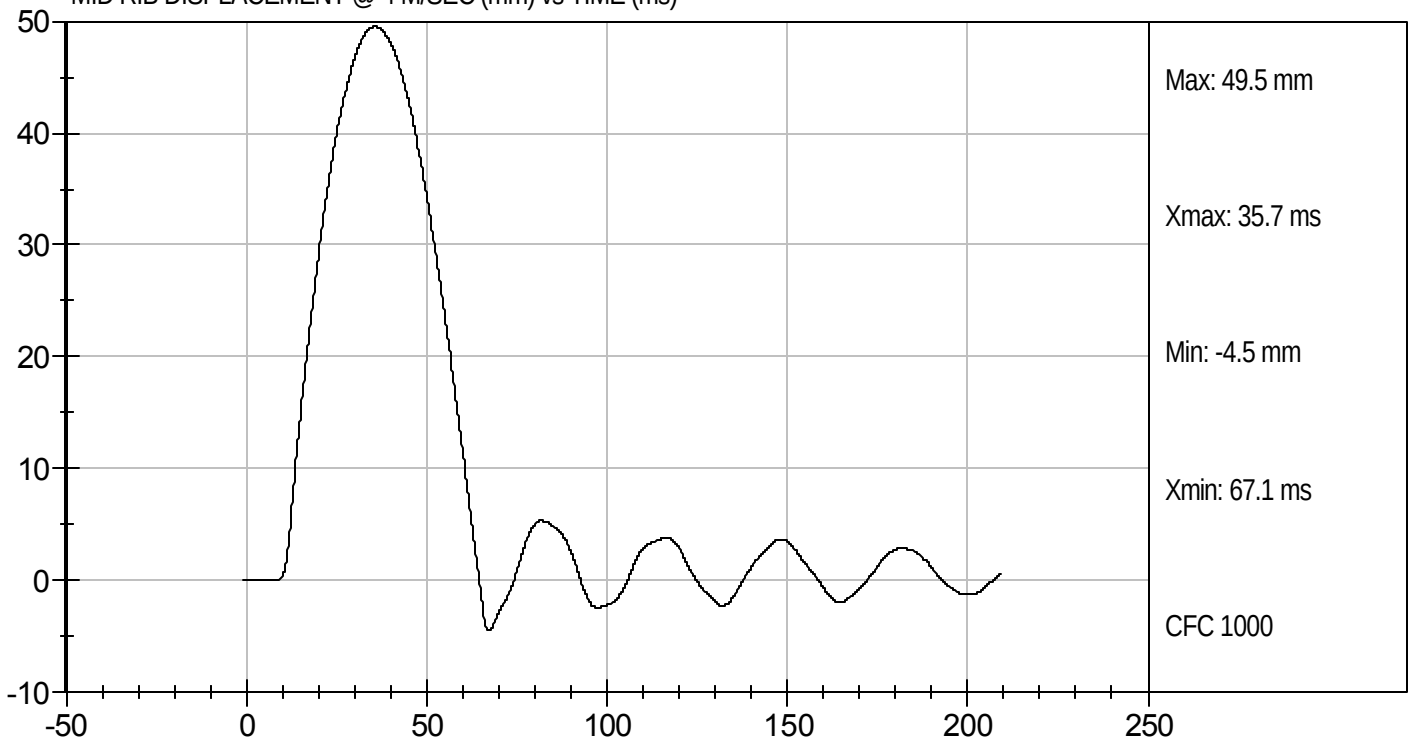
David Winkelbauer
Approved By

Test Desc: Rib Impact - Mid
Component ID: D111275
Test Date: 4/4/11

MID RIB DISPLACEMENT @ 3 M/SEC (mm) vs TIME (ms)



MID RIB DISPLACEMENT @ 4 M/SEC (mm) vs TIME (ms)



MGA RESEARCH CORPORATION

LOWER RIB TEST

ES-2re DUMMY

ATD Serial No: 016 **Test I.D:** D111276

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	20.6 to 22.2	22.1	Pass
Laboratory Relative Humidity	%	10 to 70	32	Pass
Displacement at 3 m/s	mm	36.0 to 40.0	38.0	Pass
Displacement at 4 m/s	mm	46.0 to 51.0	49.3	Pass
		Overall Test Results		Pass

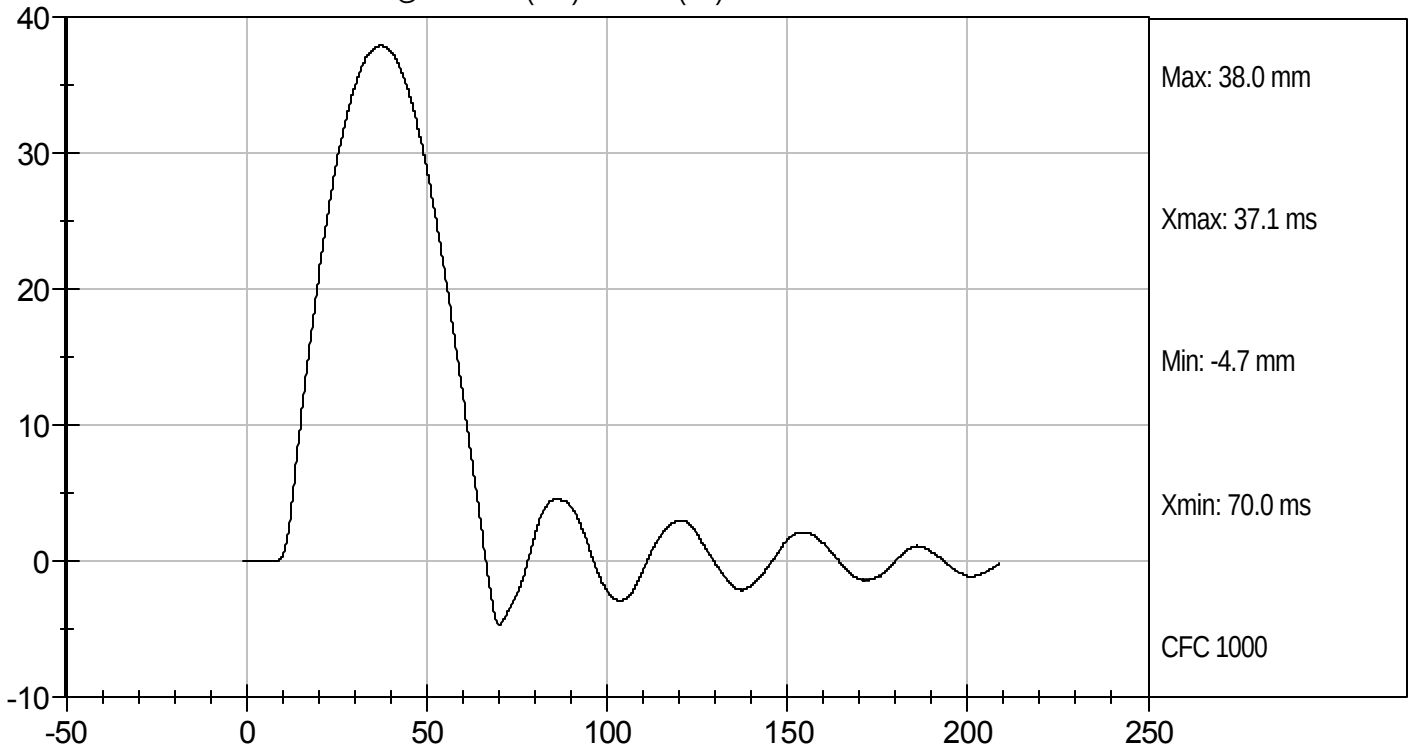
Jessica Hall
Laboratory Technician

4/4/11
Test Date

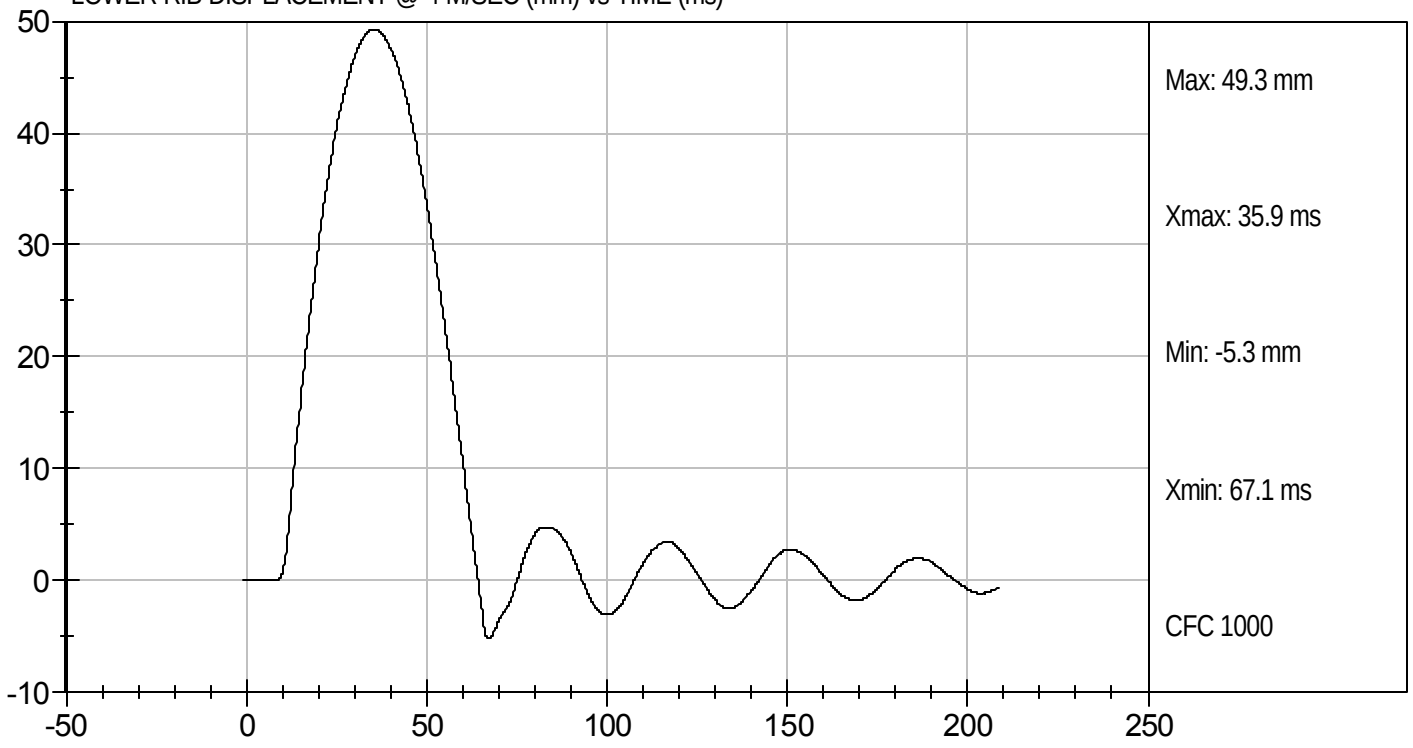
David Winkelbauer
Approved By

Test Desc: Rib Impact - Lower
Component ID: D111276
Test Date: 4/4/11

LOWER RIB DISPLACEMENT @ 3 M/SEC (mm) vs TIME (ms)



LOWER RIB DISPLACEMENT @ 4 M/SEC (mm) vs TIME (ms)



MGA RESEARCH CORPORATION

ABDOMEN TEST

ES-2re DUMMY

ATD Serial No: 016 **Test I.D:** D111277

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	20.6 to 22.2	21.7	Pass
Laboratory Relative Humidity	%	10 to 70	35	Pass
Probe Speed	m/s	3.90 to 4.10	4.1	Pass
Maximum Impact Force	kN	4.00 to 4.80	4.53	Pass
Time of Maximum Impactor Force	ms	10.60 to 13.00	11.10	Pass
Maximum Total Abdomen Force	kN	2.20 to 2.70	2.60	Pass
Time of Maximum Abdomen Force	ms	10.00 to 12.30	10.50	Pass
		Overall Test Results		Pass

Jessica Hall
Laboratory Technician

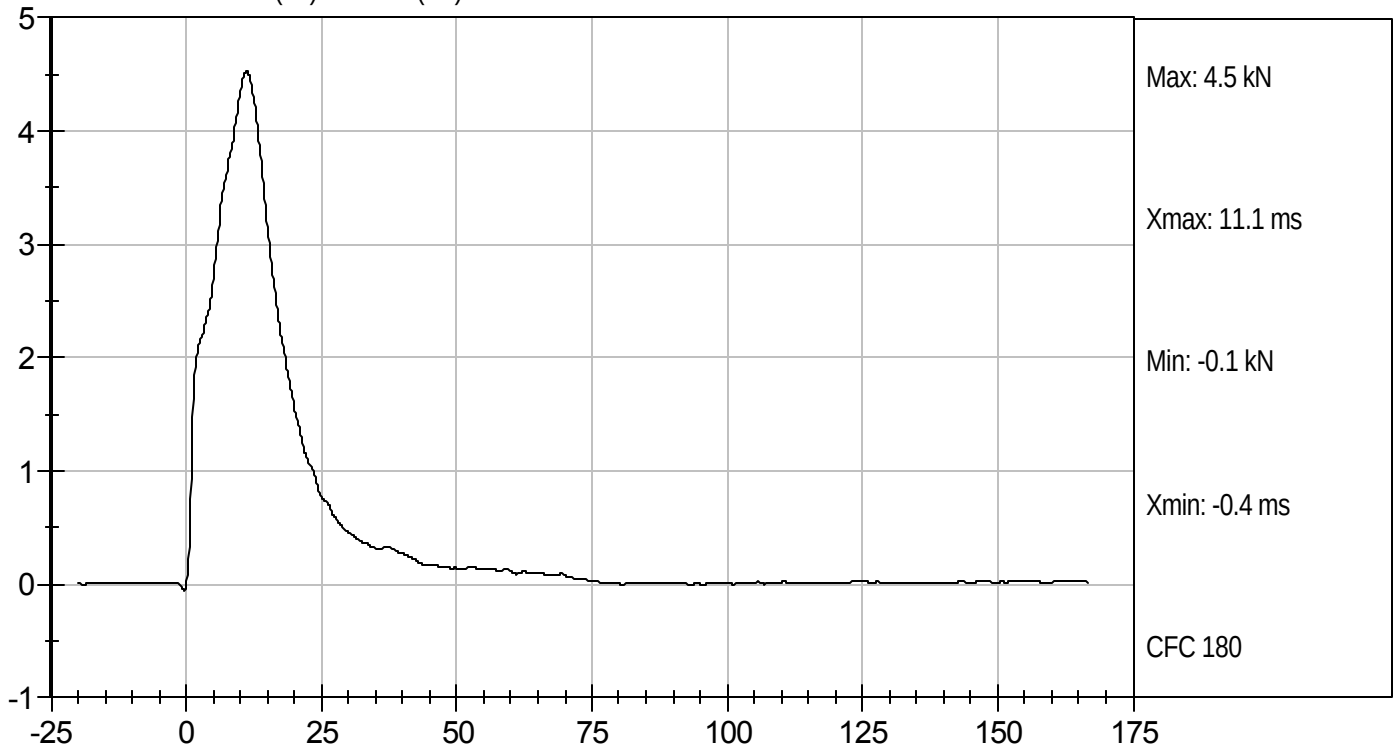
4/4/11
Test Date

David Winkelbauer
Approved By

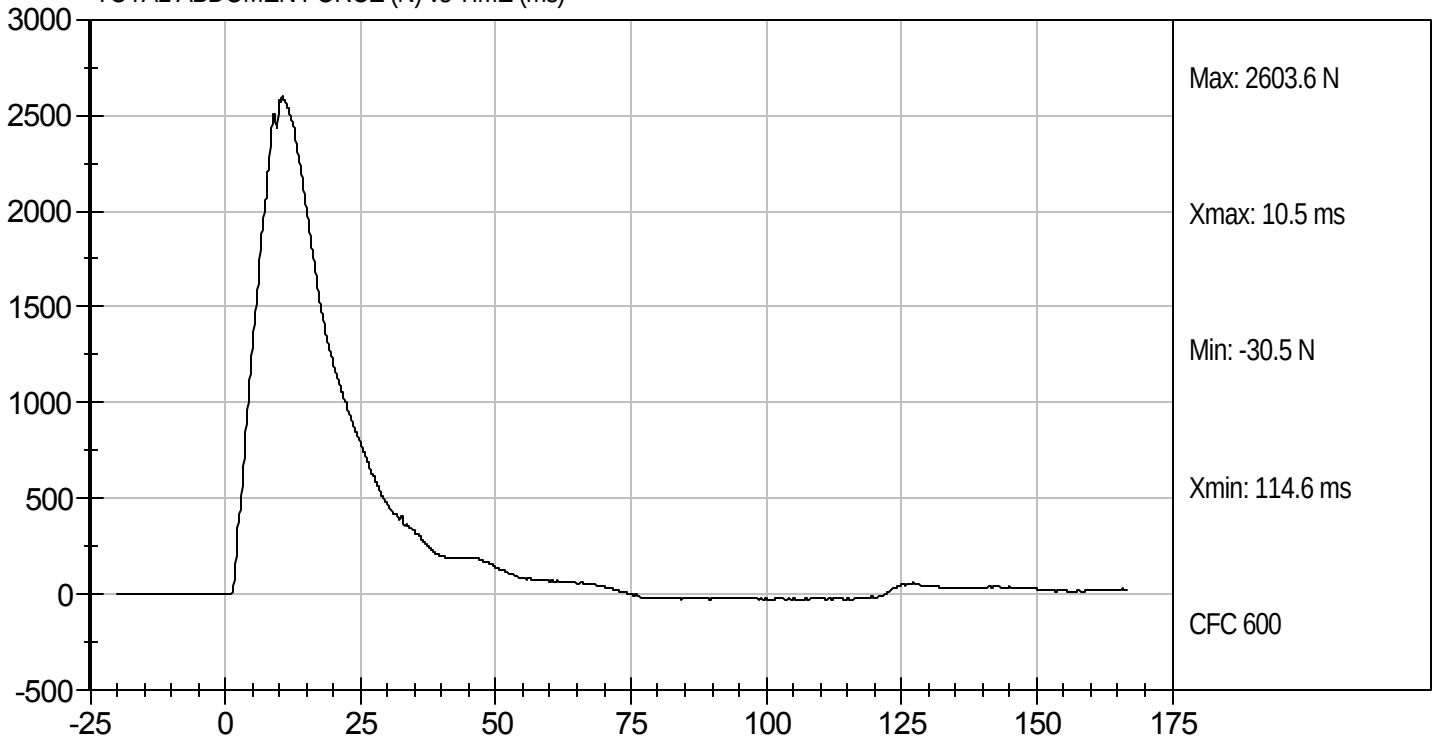
Test Desc: Abdomen Impact
Component ID: D111277

Test Date: 4/4/11
Velocity: 13.44 ft/s, 4.1 m/s

IMPACTOR FORCE (kN) vs TIME (ms)



TOTAL ABDOMEN FORCE (N) vs TIME (ms)



MGA RESEARCH CORPORATION

LUMBAR SPINE TEST

ES-2re DUMMY

ATD Serial No: 016 **Test I.D:** D111278

Tested Parameter		Units	Specification	Result	Pass/Fail
Laboratory Temperature		deg C	20.6 to 22.2	22.1	Pass
Laboratory Relative Humidity		%	10 to 70	32	Pass
Pendulum Speed		m/s	5.95 to 6.15	6.12	Pass
Pendulum Deceleration	1 ms	m/s	-0.05 to 0.00	-0.02	Pass
	3.7 ms	m/s	-0.425 to -0.24	-0.42	Pass
	27 ms	m/s	-6.50 to -5.80	-5.83	Pass
	30 ms	m/s	>= -6.5	-6.17	Pass
Maximum Flexion Angle		deg	45.0 to 55.0	46.0	Pass
Time of Maximum Flexion Angle		ms	39.0 to 53.0	42.4	Pass
Headform Rotation Decay to Initial Position		ms	37 to 57	44	Pass
			Overall Results		Pass

Jessica Hall
Laboratory Technician

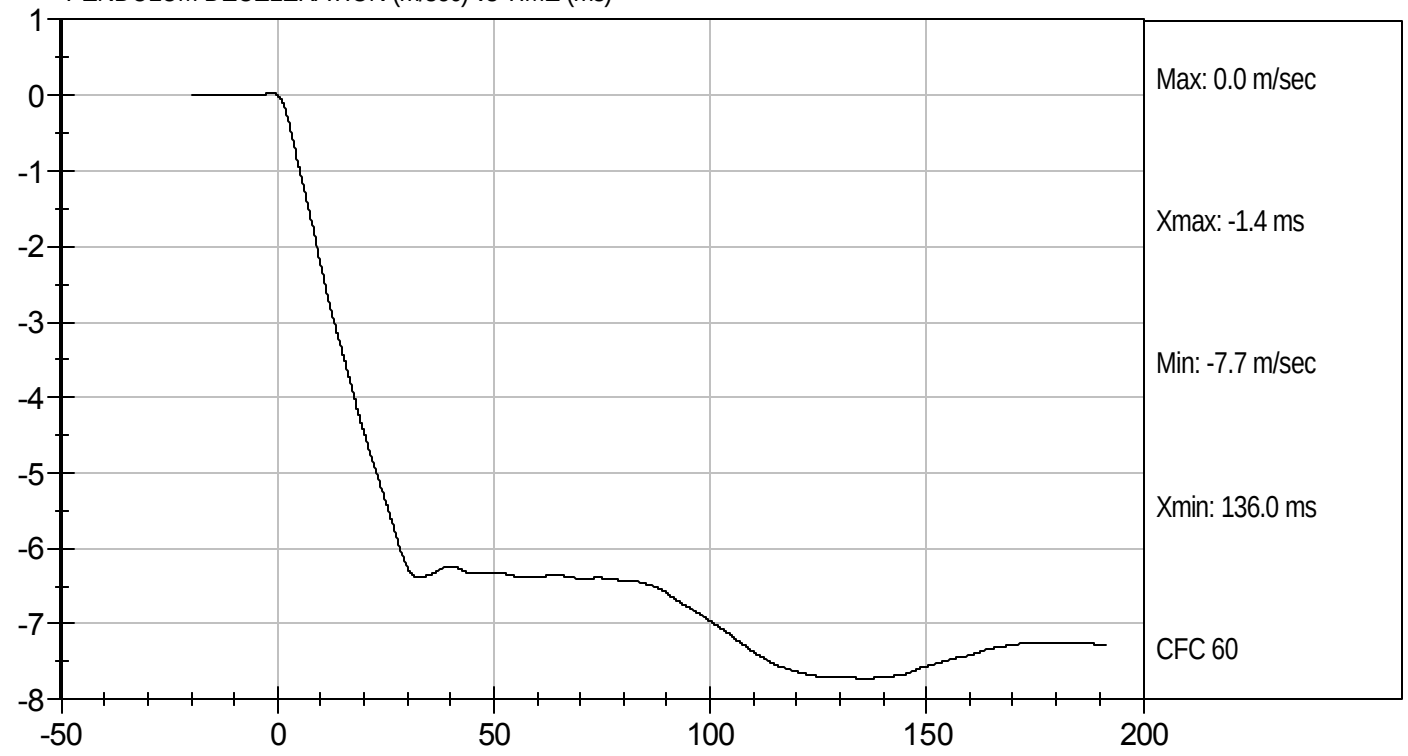
4/4/11
Test Date

David Winkelbauer
Approved By

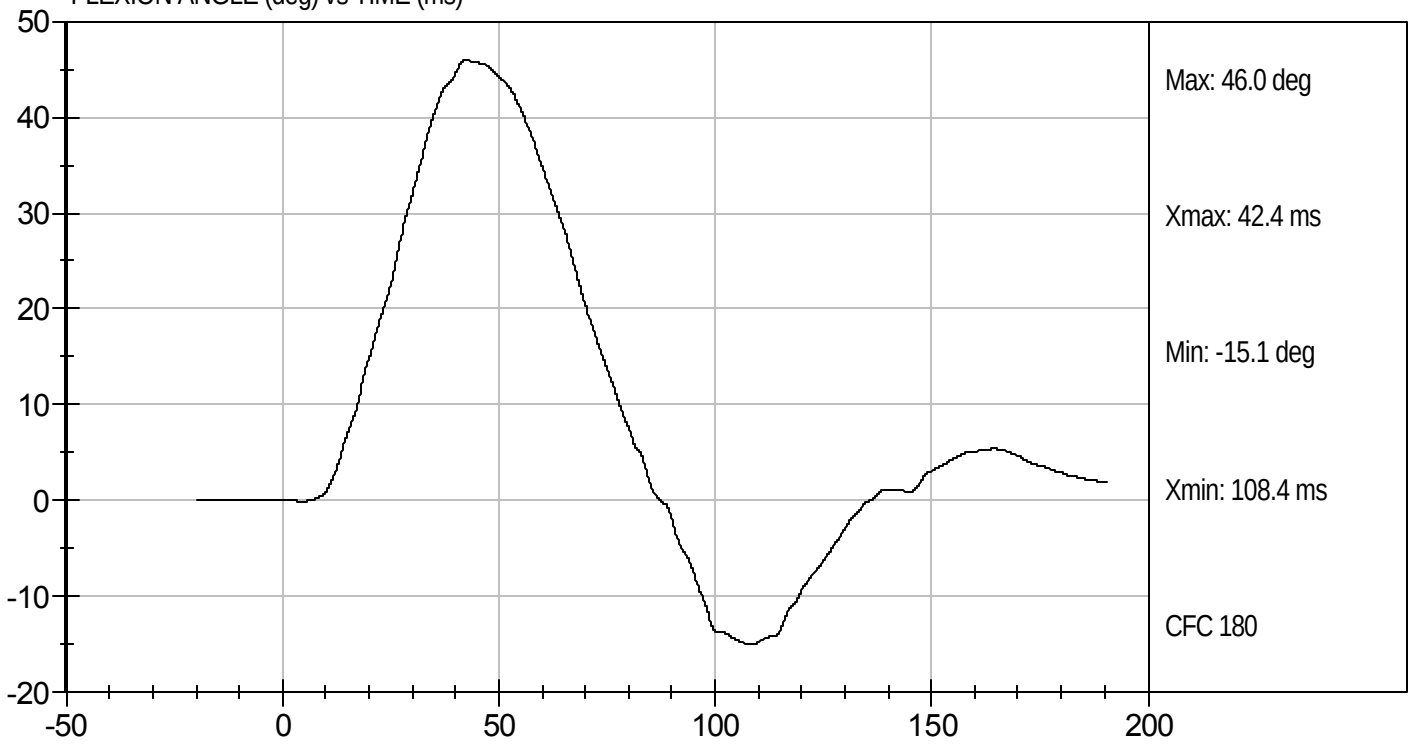
Test Desc: Lumbar Bending
Component ID: D111278

Test Date: 4/4/11
Velocity: 20.08 ft/s, 6.12 m/s

PENDULUM DECELERATION (m/sec) vs TIME (ms)

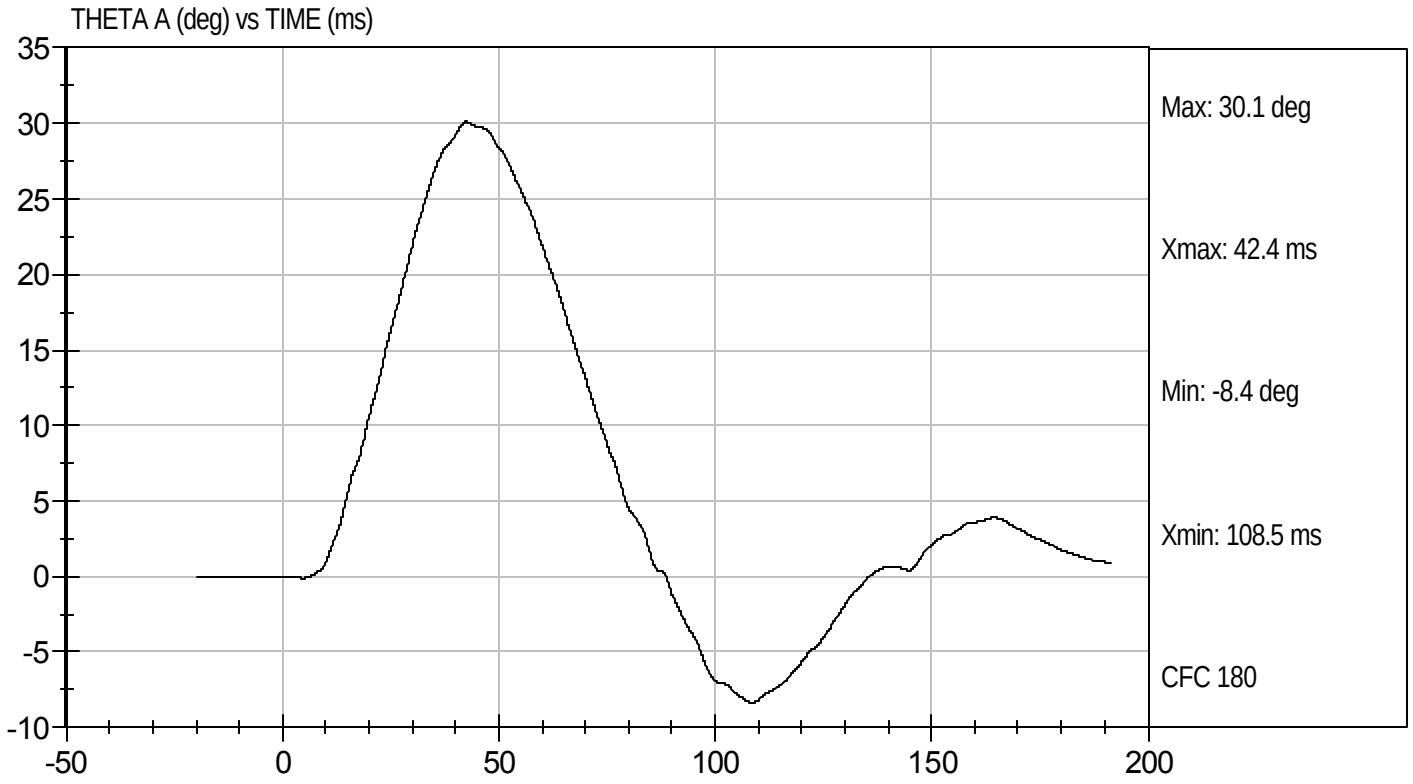


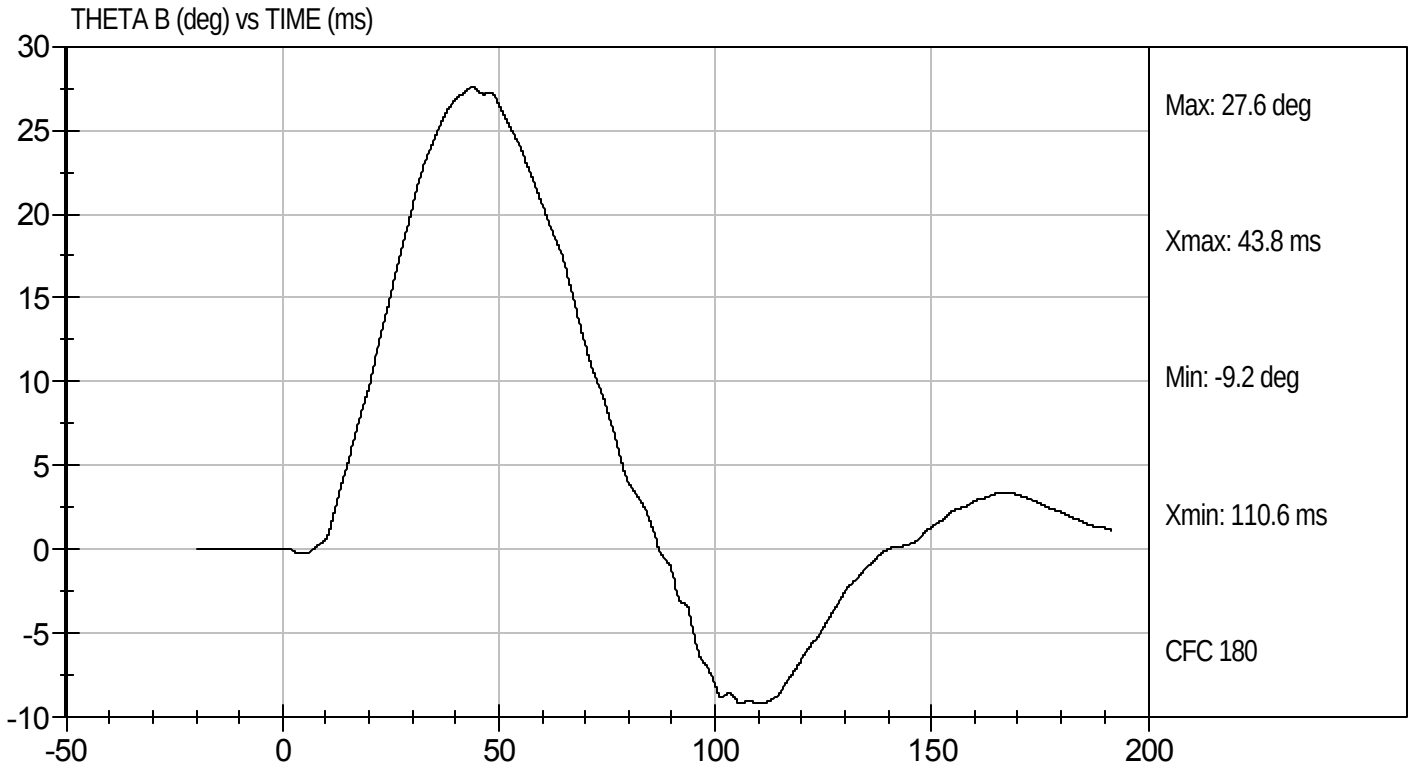
FLEXION ANGLE (deg) vs TIME (ms)



Test Desc: Lumbar Bending
Component ID: D111278

Test Date: 4/4/11
Velocity: 20.08 ft/s, 6.12 m/s





MGA RESEARCH CORPORATION

PELVIS TEST

ES-2re DUMMY

ATD Serial No: 016 **Test I.D:** D111279

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	20.6 to 22.2	21.8	Pass
Laboratory Relative Humidity	%	10 to 70	34	Pass
Probe Speed	m/s	4.20 to 4.40	4.34	Pass
Maximum Impactor Force	kN	4.70 to 5.40	4.92	Pass
Time of Maximum Impactor Force	ms	11.80 to 16.10	14.00	Pass
Maximum Pubic Force	kN	1.23 to 1.59	1.51	Pass
Time of Maximum Pubic Force	ms	12.20 to 17.00	14.90	Pass
		Overall Test Results		Pass

Jessica Hall
Laboratory Technician

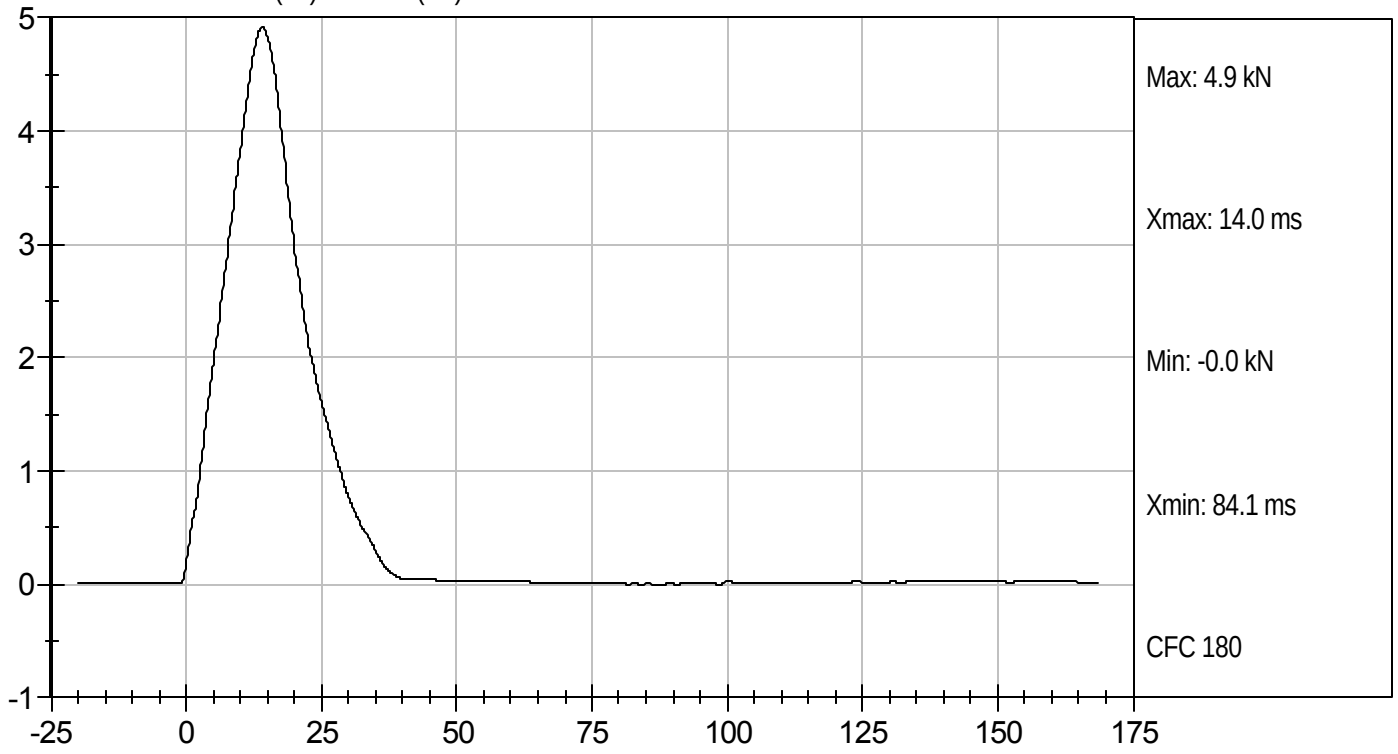
4/4/11
Test Date

David Winkelbauer
Approved By

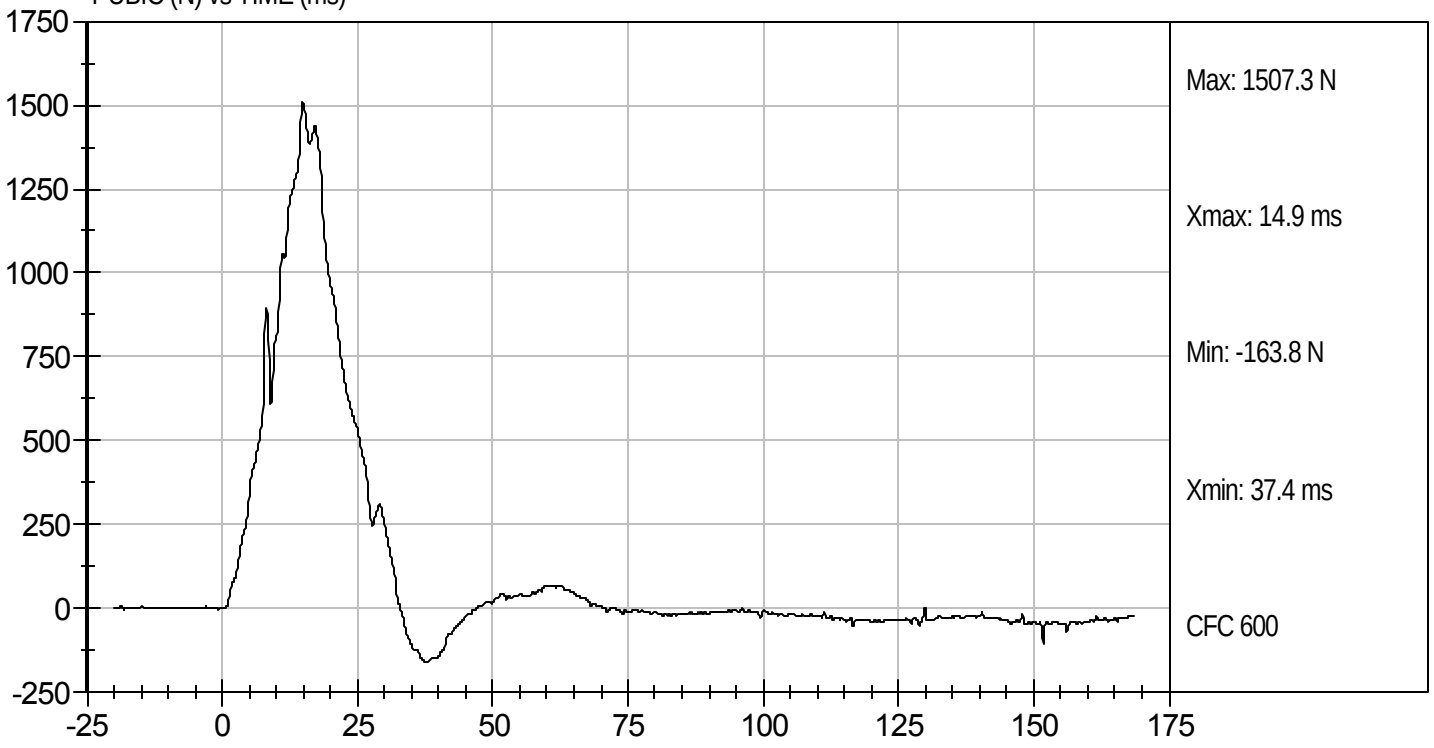
Test Desc: Pelvis Impact
Component ID: D111278

Test Date: 4/4/11
Velocity: 14.25 ft/s, 4.34 m/s

IMPACTOR FORCE (kN) vs TIME (ms)



PUBIC (N) vs TIME (ms)



MGA RESEARCH CORPORATION

FULL BODY THORAX IMPACT TEST

ES-2re DUMMY

ATD Serial No: 016 **Test I.D:** D111270

Tested Parameter	Units	Specification	Result	Pass/Fail
Temperature	deg C	20.6 to 22.2	21.6	Pass
Humidity	%	10 to 70	34	Pass
Probe Speed	m/s	5.40 to 5.60	5.58	Pass
Maximum Impactor Force (after 6 ms)	kN	5.10 to 6.20	5.17	Pass
Upper Rib Displacement	mm	34.0 to 41.0	40.3	Pass
Middle Rib Displacement	mm	37.0 to 45.0	41.9	Pass
Lower Rib Displacement	mm	37.0 to 44.0	40.0	Pass
		Overall Test Results		Pass

Jessica Hall
Laboratory Technician

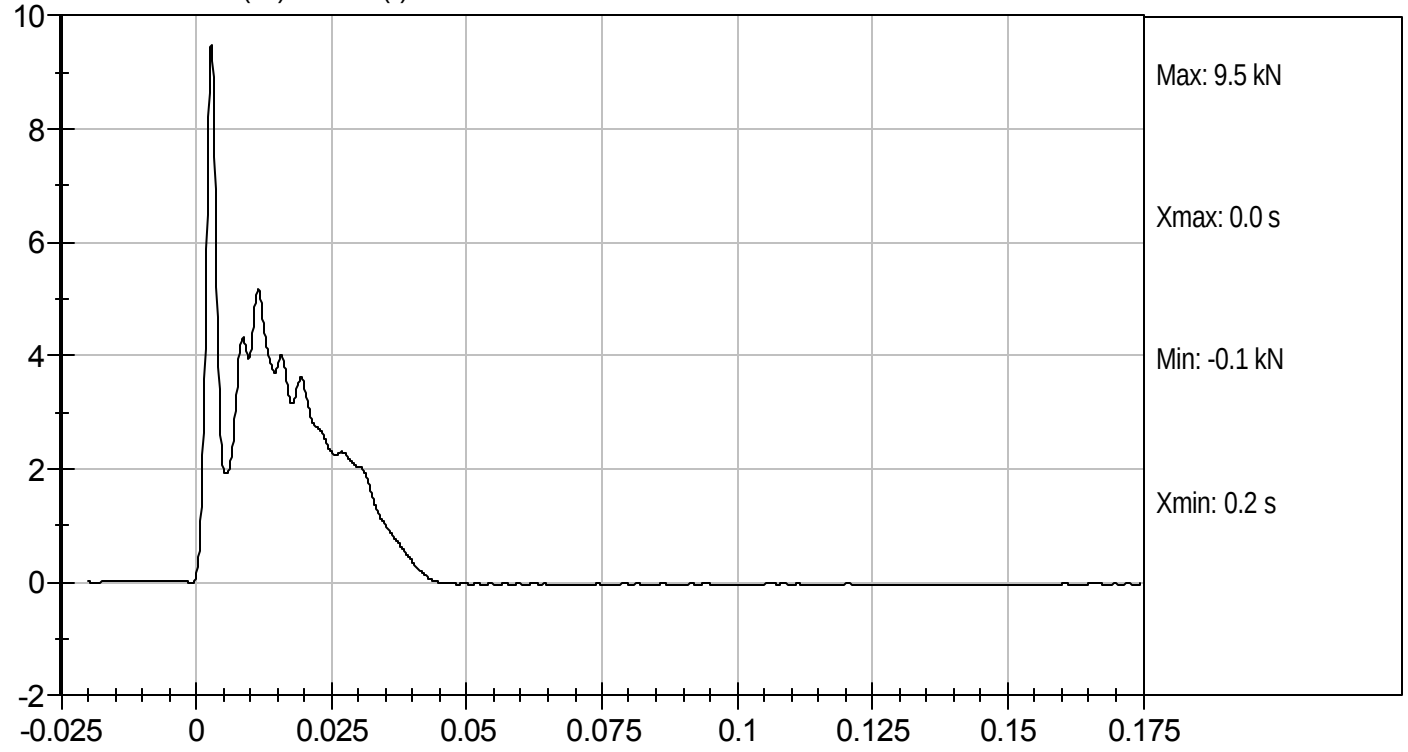
4/4/11
Test Date

David Winkelbauer
Approved By

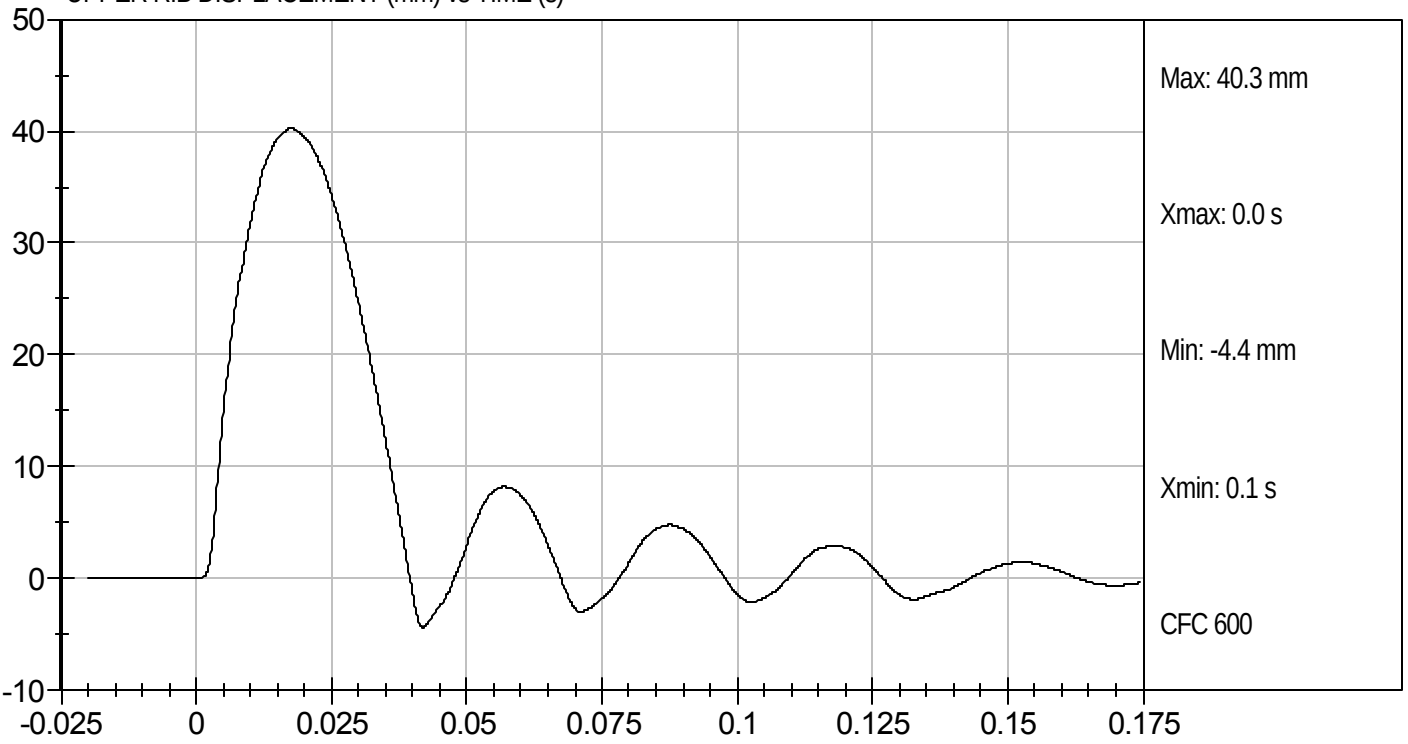
Test Desc: Thorax Impact
Component ID: D111270

Test Date: 4/4/11
Velocity: 18.32 ft/s, 5.58 m/s

PROBE FORCE (kN) vs TIME (s)

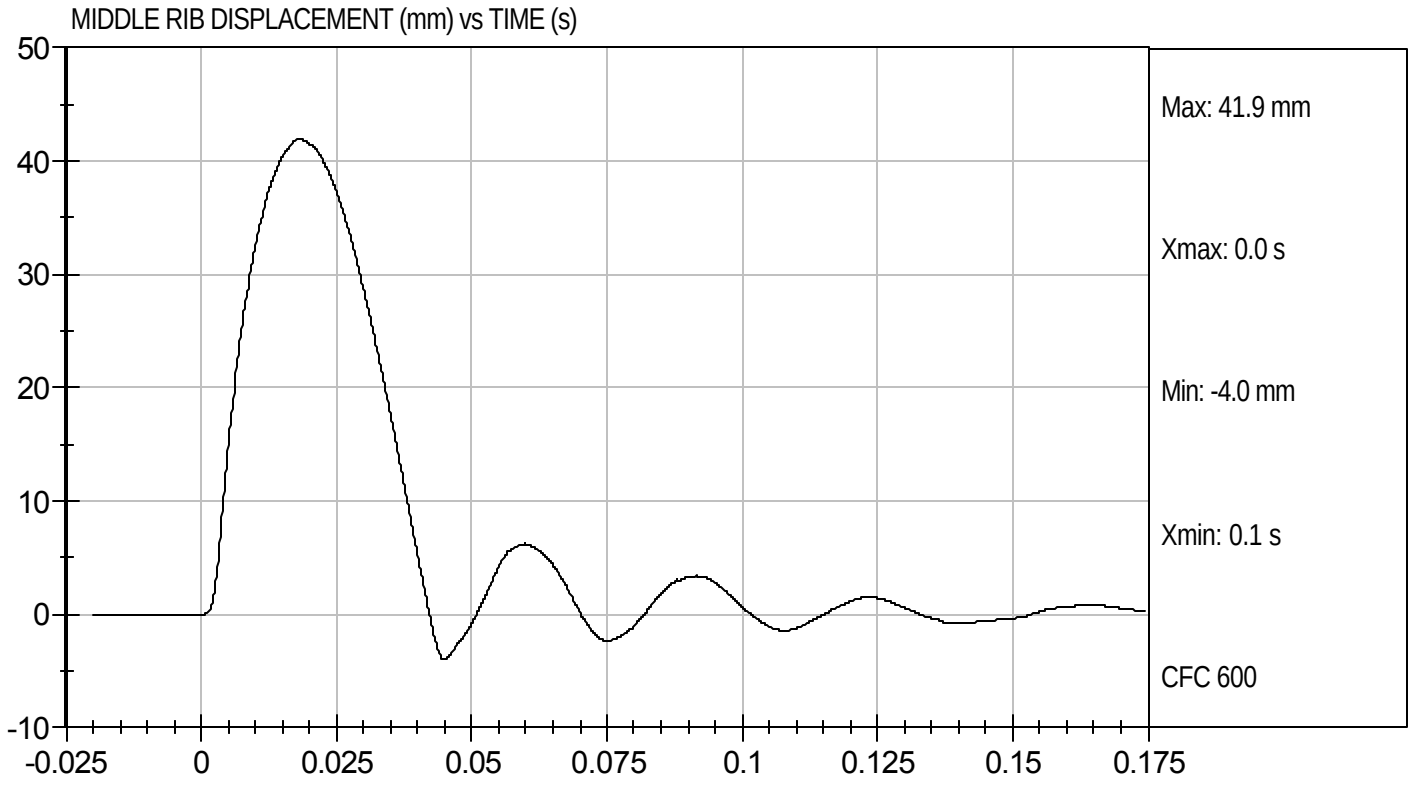


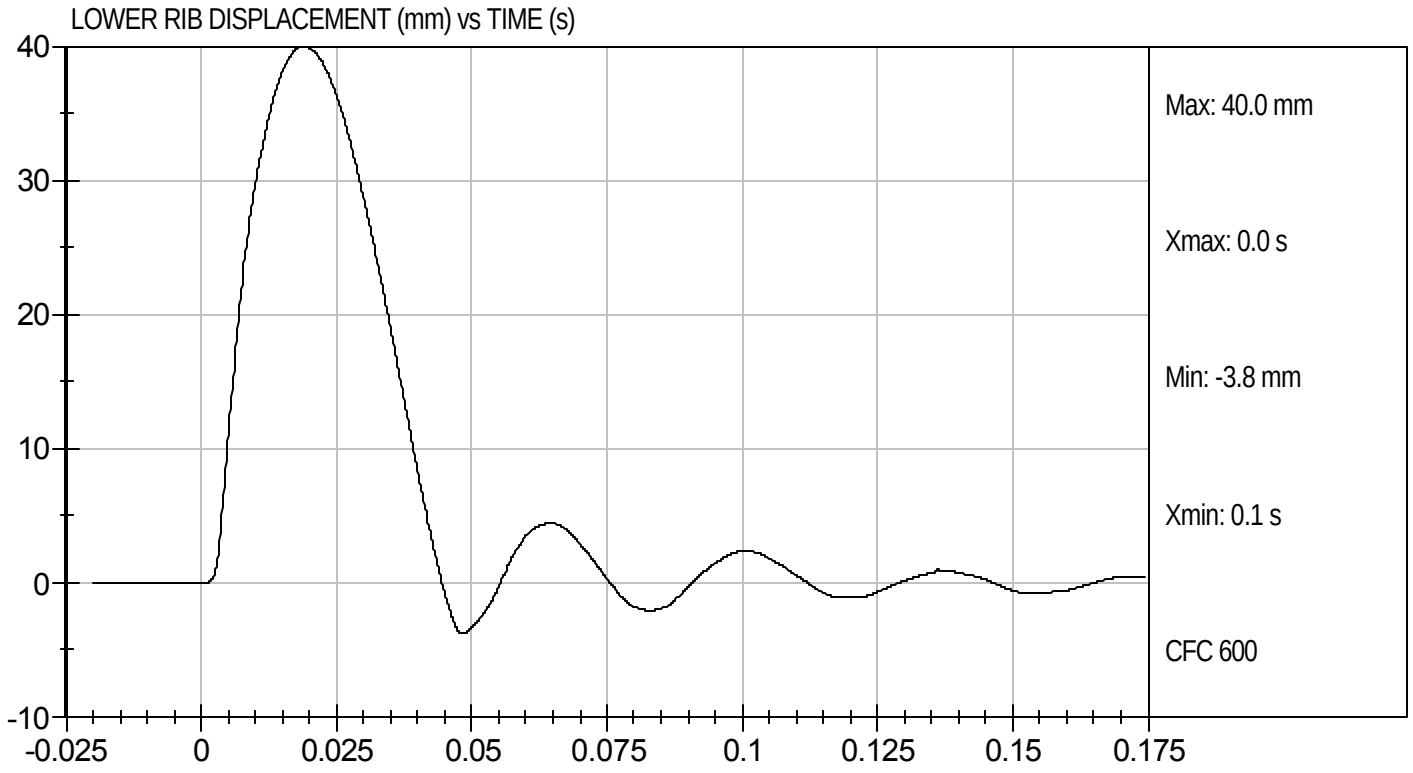
UPPER RIB DISPLACEMENT (mm) vs TIME (s)



Test Desc: Thorax Impact
Component ID: D111270

Test Date: 4/4/11
Velocity: 18.32 ft/s, 5.58 m/s





APPENDIX E

TEST EQUIPMENT AND INSTRUMENTATION CALIBRATION

Table 1 – Dummy Instrumentation

		ES-2re S/N: 016		
		Serial Number	Manufacturer	Calibration Date
Head Accelerometers	X	P66854	Endevco	2/14/2011
	Y	P66855	Endevco	2/14/2011
	Z	P66856	Endevco	2/14/2011
Thorax Potentiometers	Upper Rib (Y)	G144	Honeywell	2/17/2011
	Middle Rib (Y)	G143	Honeywell	2/17/2011
	Lower Rib (Y)	G142	Honeywell	2/17/2011
Abdomen Load Cells	Forward (Y)	ABG119	FTSS	11/01/2010
	Middle (Y)	ABG120	FTSS	11/01/2010
	Rear (Y)	ABG121	FTSS	11/01/2010
Pubic Symphysis Load Cell (Y)		PG431	Denton	11/01/2010

Table 2 – Vehicle Instrumentation

	Serial Number	Manufacturer	Calibration Date
Vehicle CG (X)	P59374	Endevco	3/16/2011
Vehicle CG (Y)	P59372	Endevco	3/16/2011
Vehicle CG (Z)	P59373	Endevco	3/16/2011
Left Floor Sill (Y)	P59283	Endevco	1/13/2011
A Pillar Sill (Y)	P59244	Endevco	12/03/2010
A Pillar Low (Y)	P49518	Endevco	12/22/2010
A Pillar Mid (Y)	P50058	Endevco	3/15/2011
B Pillar Sill (Y)	P59249	Endevco	12/13/2010
B Pillar Low (Y)	P37915	Endevco	1/13/2011
B Pillar Mid (Y)	P49525	Endevco	1/13/2011
Seat (Y)	P59247	Endevco	11/05/2010
Engine (X)	P49520	Endevco	2/19/2011
Engine (Y)	P49521	Endevco	2/19/2011
Firewall (Y)	P59360	Endevco	1/13/2011
Roof (Y)	P49475	Endevco	12/03/2010
Floor Sill (Y)	P59285	Endevco	2/19/2011
Rear Deck (X)	P49490	Endevco	3/15/2011
Rear Deck (Y)	P49491	Endevco	3/15/2011